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BULLETIN OF THE TORREY BOTANICAL CLUB
VOL. 80, NO. 5, PP. 365–384 SEPTEMBER, 1953

A COMPARISON OF THE SECONDARY XYLEM ELEMENTS OF CERTAIN SPECIES OF THE AMENTIFERAE AND RANALES

ALICE E. PETERSEN

Since the time of Linnaeus the "Amentiferae" have been considered a group of great morphological and taxonomical interest. Engler and Prantl and many other botanists of the nineteenth century believed them to be a very primitive group of dicotyledons descended from gymnosperms of the Gnetalian type with unisexual strobili which were considered homologous to the aments or catkins of the Amentiferae (Engler and Prantl 1897, Engler and Diels 1936).

On the other hand, C. E. Bessey (1915) and his followers considered the Amentiferae derived, not primitive. They regarded them as a specialized group, simple by reduction, and believed the Ranales to be the basal group of the dicotyledons.

Both views have had impressive advocates. Followers of Engler and Prantl who have placed the Amentiferae in a low position include Britton (Britton and Brown 1913), A. B. Rendle (1925), Warming and Möbius (1929), A. M. Johnson (1931) and Wettstein (1935). Aligned with Bessey are Bentham and Hooker (1862–1883), Gray[1] (1867), Arber and Parkin (1907), Hallier (1908), Lotsy (1907–1911), Hutchinson (1926, 1929), and Strasburger (1930). Hutchinson, however, excluded the Juglandaceae from the Amentiferae, since he believed that they were not genetically close, largely because of their compound leaves.

Most modern American plant taxonomists and anatomists accept the Amentiferae as an advanced, heterogeneous group, simple by reduction (Eames 1929, Tippo 1938, Pool 1941, Swingle 1946, Eames and MacDaniels 1947, Lawrence 1951). Many workers on the floral anatomy of individual families of the Amentiferae also consider them a specialized group (Holden 1912; Bechtel 1921; Fisher 1928a, 1928b; Boothroyd 1930; Abbe 1935, 1938; Manning 1938, 1940). According to Turrill (1942) the pollen grains of the Salicaceae, Juglandaceae, Betulaceae, Fagaceae and Casuarinaceae show unmistakable signs of reduction. However, the Amentiferae have been recently reëxamined by the Swedish botanist, Hjelmqvist (1948), who swings back the pendulum to rest again with Engler, Wettstein and Rendle.

Most of the above mentioned botanists have based their opinions largely on floral morphology. According to Fritsch (1903), Record (1934b, 1935),

[1] Some later revisers of Gray's manual (Robinson and Fernald 1908, Fernald 1950) have followed Engler and Prantl.

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Tippo (1938, 1946), Bailey (1944b, 1949, 1951) and many other able wood anatomists, no natural system of angiosperm classification can be established without the combined work of taxonomists, anatomists, cytologists, paleobotanists, geneticists, embryologists and specialists in other fields of botanical research. It appears that the Amentiferae will continue to be tossed about until all evidence is collected from all parts of the plants by researchers from all botanical fields.

This paper has been written with the hope that it will add to the increasing amount of evidence that, from the point of view of wood anatomy, the Amentiferae are an advanced rather than a primitive group.

Materials and methods. Ideally the writer should have used homologous regions of the trees and shrubs studied in this comparative anatomical report (Bailey and Faull 1934). Mature wood was taken whenever possible, and twigs under three years of age were avoided in all but three cases.

Species[2] studied and their sources were as follows: Wood blocks from the National Lumber Manufacturers Association:

Amentiferae
Betula lutea Michx.
Juglans nigra L.
Fagus grandifolia Ehrh.
Castanea dentata Sudworth
Salix nigra Marsh.
Populus deltoides Marsh.

Ranales
Magnolia grandiflora L.
Liriodendron Tulipifera L.

Herbarium specimens from the New York Botanical Garden:

Amentiferae
Balanops australiana F.v. Muell. (1-yr. twig)
Alfaroa costaricensis Standl.
Engelhardtia pterocarpa (Oerst.) Standl.
Pterocarya stenoptera C. DC.
Leitneria floridana Chapm.
Nothofagus antarctica (Forst.) Oerst. (wood block)
Lithocarpus densiflora (H. and A.) Rehder
Castanopsis chrysophylla A. DC. (wood block)

Ranales
Manglietia hainanensis Dandy
Michelia fuscata Blume
Talauma mexicana G. Don.
Drimys Winteri J.R. and G. Forst. var. andina Reiche
Pseudowintera axillaris (J.R. and G. Forst.) Dandy var. colorata (Raoul) A.C. Sm.
Schizandra glabra (Brickell) Rehder
Kadsura coccinea (Lem.) A.C. Sm.
Degeneria vitiensis I. W. Bailey and A.C. Sm. (1-yr. twig)
Himantandra Belgraveana (F.v. Muell.) F.v. Muell.
Lactoris fernandeziana Phil. (1-yr. twig)
Paeonia suffruticosa Andr.

[2] More detailed information concerning the above specimens may be found in an expanded version of this paper in the Hunter College Library.

Mature wood specimens from the New York Botanical Garden arboretum:

Amentiferae
Ostrya virginiana C. Koch
Corylus Avellana L.

Ranales
Cercidiphyllum japonicum Sieb. and Zucc.
Clematis dioscoreifolia Lévl. and Vaniot

Mature wood specimens from the New York Botanical Garden greenhouse:

Ranales
Illicium anisatum L.

Mature wood specimens collected by the writer:

Amentiferae
Alnus serrulata Willd.
Carpinus caroliniana Walt.
Myrica pensylvanica Hort. Rex ex Lamr.
Comptonia peregrina (L.) Coult.
Carya glabra Sweet
Quercus alba L.

Macerated material was used for most of the observations in this report. Small slivers of the wood of each specimen were placed in 5% aqueous chromic acid for 24 hours. Then they were washed thoroughly in distilled water and put into 70% ethyl alcohol. Several permanent slides of each specimen were then prepared with P.V.A.[3] lacto-phenol as the mounting medium, the slivers being teased apart in the usual manner with dissecting needles.

All measurements were made from slides prepared in the above manner. The measuring was done with an ocular micrometer calibrated by means of a stage micrometer. In determining the length of vessel members the writer used "Method D" of Chalk and Chattaway (1934), i.e., the *total* length of the vessel member was measured on macerated material.

The measurements are not intended to represent the mean for each species. Tippo (1941) lists 100 as the recommended number of length measurements for vessel elements, tracheids and fibers of each species, and the same number for the diameter of vessel members. Rendle and Clarke (1934b) suggest that 100 vessel members and 100 fibers should be measured if only one sample of a species is available, and 25 from each sample if more than one is available. They point out (Rendle and Clarke 1934a) that to get a mean for a species accurate to within plus or minus 10% of the actual mean for vessel diameter, for instance, it would be necessary to measure 25 vessels selected at random from each of five samples taken from each of four trees. Desch (1934b), working on fiber length and vessel diameter, concluded that not less than 300 measurements are needed to render

[3] Polyvinyl alcohol ("Elvanol"), a product of E. I. duPont de Nemours and Co., Wilmington, Delaware.

the differences between the means significant. Since such procedures were not possible in this report, the writer measured only 25 vessel elements, fibers, etc. of each species. Such measurements, although worthless for determining the mean for each species, have some value in this type of report when correlated with other anatomical findings. No standard deviation and standard error were recorded because, as Desch (1932a) points out, "It is important to bear in mind that data collected by bad sampling will become no more illuminating by the calculation of standard errors; such treatment may merely lend spurious support to false conclusions."

In measuring vessel elements of species with ring porous wood, the writer tried to obtain an equal number of samples from both the early and late wood.

The angles of the end walls of the vessel elements were measured in tangential view with an ocular protractor (not precise).

For detailed examination of the pits of xylem elements Foster's (1949) saturated solution of phloroglucinol prepared in 18% hydrochloric acid was used. A very thin shaving (dry, not macerated) was placed in this solution for a few minutes, then teased apart in a drop of the medium on a microscope slide and mounted with a cover glass.

The following technique previously used by the writer in making some camera lucida drawings showed up pit and perforation plate borders very well: A very small sliver of macerated wood was placed for about 10 minutes in a 3% aqueous solution of light green—SF—yellowish. After the excess stain was drained off with filter paper, the specimen was transferred to a drop of dilute glycerine on a microscope slide, where the fibers were teased apart in the usual manner with dissecting needles. A cover glass was added and ringed with straight P.V.A. A 3% aqueous solution of methylene blue is also satisfactory provided that overstaining is avoided. A one minute immersion of the specimen, in this case, is usually sufficient.

Prepared slides of radial, tangential and transverse sections of the wood of each specimen were also examined. Where these were not available, sections were made with a Spencer table microtome and stained in the usual manner with hematoxylin and safranin. These were sufficient for examining pore distribution, cross-sectional outlines of pores, type of rays and wood parenchyma.

The following lines of structural evolution in secondary xylem were considered in comparing the Amentiferae and Ranales:

1. Absence of vessels is considered primitive in angiospermous secondary wood (Thompson and Bailey 1916; Bailey and Thompson 1918; Bailey 1944a; Bailey and Nast 1945a, 1945b).
2. Vessel elements with scalariform perforation plates are considered more primitive than those with simple perforation plates (Jeffrey 1917;

Bailey and Tupper 1918; Thompson 1918, 1923; Bliss 1921; Frost 1930a, 1930b; Bailey 1944b).

3. Perforation plates with many bars (over 15) are less specialized than those with few (5 or less) (Frost 1930b).

4. Narrow openings (i.e., six microns or less from bar to bar) in scalariform perforation plates are less specialized than those with wide openings (Frost 1930b).

5. Apertures of perforation plates with complete borders are considered more primitive than those with borders only to the middle of the orifice, and the latter are considered more primitive than those with borders only at the end of the orifice, whereas non-bordered apertures are least primitive (Frost 1930b).

6. Vessels with long, sloping end walls are considered more primitive than those with only slightly oblique or transverse end walls (Bailey and Tupper 1918, Frost 1930b).

7. There is a decrease in length of the vessel element with specialization (Bailey and Tupper 1918, Bailey 1920, Frost 1930a).

8. The diameter of the vessel element increases with specialization (Bailey and Tupper 1918, Bailey 1920, Frost 1930a).

9. Vessel members with angular cross-sectional outlines are considered more primitive than those with round outlines (Bailey 1924, Frost 1930a).

10. Thin-walled vessel elements are considered less specialized than those with thick walls (Frost 1930a).

11. Intervascular lateral wall pitting of the scalariform type is considered most primitive, followed by transitional and then opposite pitting. Alternate intervascular lateral wall pitting is considered most specialized (Brown 1918; Bailey and Tupper 1918; Frost 1930a, 1931; Metcalfe and Chalk 1950). Also, fully-bordered pits are considered more primitive than half-bordered pits, and the latter more primitive than non-bordered (simple) pits (Frost 1931). In this report, bordered and half-bordered pits are listed as "bordered," since the dominant type could not be determined accurately with the material and facilities available to the writer.

12. Vessel-parenchyma pitting follows the same general sequence listed under intervascular pitting (Brown 1918; Bailey and Tupper 1918; Frost 1930a, 1931; Metcalfe and Chalk 1950).

13. Diffuse porous wood, i.e., that with vessels of about the same diameter and more or less evenly distributed throughout each growth ring (Stover 1950), is considered more primitive than ring porous wood, i.e., that with the largest and greatest number of vessels in the early wood (Stover 1950). Some think that ring porosity is ecological, being associated with cold winters or alternating wet and dry seasons, and hence should not be considered in questions of evolutionary significance (Metcalfe and Chalk 1950), but

Frost (1930a) and Gilbert (1940) found a high degree of correlation between ring porosity and the presence of structural features whose advanced nature has been generally conceded. In any case, "the advent of ring porosity or some factor or factors causing ring porosity seems to give impetus to anatomical specialization" (Tippo 1938).

14. (Still controversial) Vessels without spiral thickenings are generally considered more primitive than those with spiral thickenings (Frost 1931). However, Metcalfe and Chalk (1950) point out that the spiral thickening of the secondary wall of a vessel may be an ecological specialty associated with ring porosity and that it occurs sporadically. They maintain that it is relatively more common in unspecialized than in specialized woods, whereas Bailey and Frost (Frost 1931) claim that spirals do not generally occur in the most primitive dicotyledonous woods.

15. In regard to pore distribution, solitary pores are considered more primitive than aggregate pores, i.e., pore multiples, pore clusters and pore chains (Tippo 1938, 1946; Metcalfe and Chalk 1950).

16. The evolutionary sequence of imperforate tracheary elements is considered to have proceeded from tracheids to fiber-tracheids to libriform wood fibers (Jeffrey 1917; Bailey and Tupper 1918; Bailey, 1924, 1936). The above terms have been used with slightly different meanings by different writers. Bailey's (1936) interpretations of these terms are used in this report and are as follows:

Tracheids—elements with large bordered pits (approximately equal in size to pits of vessel members) and no end plates.

Fiber-tracheids—transitional elements having pits with obviously reduced or vestigial borders (pits conspicuously smaller than corresponding pits of vessel members).

Libriform wood fibers—elements with small simple pits. Bailey (1936) points out that there is no sharp distinction among the three types but a graded series of fluctuating forms.

17. There is a decrease in length of tracheids, fiber-tracheids and libriform wood fibers with specialization (Bailey and Tupper 1918; Bailey 1920, 1924).

18. (Still controversial) Non-septate fibers (either fiber-tracheids or libriform wood fibers) are considered more primitive than septate fibers (either septate fiber-tracheids or septate libriform wood fibers) (Tippo 1938). Chalk (1937) arrived at the opposite conclusion. Metcalfe and Chalk (1950) consider septate fibers more valuable as an indication of affinity than level of specialization. They maintain that septate fibers are found in both specialized and primitive groups but are less frequent in the most advanced woods.

19. A fiber-tracheid with large bordered pits in all walls touching other

fiber-tracheids and numerous pits to vessels is considered more primitive than a libriform wood fiber with few simple pits or no pits to vessels (Metcalfe and Chalk 1950).

20. Heterogeneous rays, i.e., those with vertically elongated cells as well as radially elongated cells, are considered more primitive than homogeneous rays, i.e., those with all cells radially elongated (Kribs 1935; Barghoorn 1940, 1941a, 1941b). According to Tippo (1938) ray width and depth do not appear to have much phylogenetic significance, varying from tree to tree depending upon the site and level and the distance from the pith at the same level.

21. In regard to wood parenchyma, absence of it is considered primitive and diffuse parenchyma is generally conceded more primitive than the various types of aggregate parenchyma (Jeffrey 1917, Kribs 1937, Metcalfe and Chalk 1950). Apotracheal parenchyma, i.e., that type not determined by vessels or solitary wood parenchyma not in contact with vessels, is in general more primitive than paratracheal parenchyma, i.e., individual parenchyma cells or aggregates of parenchyma cells in contact or association with vessel elements or vascular tracheids (Hess 1950). Since there has been much confusion in wood parenchyma terminology, the clarified terms (Plan IV) outlined by Hess (1950) are the only ones used in this research.

22. Non-stratified wood cells are less specialized than storied wood cells, i.e., the arrangement of cells or tissues in horizontal series as seen in tangential section (Record 1919a, 1934b; Bailey 1923; Janssonius 1931). Rays only, wood parenchyma only, or sometimes all elements may be storied (Metcalfe and Chalk 1950).

Tippo (1938, 1946) emphasizes the fact that the above lines of specialization are not based on any system of angiosperm classification but have been arrived at independently of any previously held idea that the Ranales or "Amentiferae" are primitive, and since these methods were founded independently of angiosperm classification they are relatively free from bias.

That the above lines of structural specialization have good support from many fields has been indicated by (1) the paleobotanical studies of Bailey and Sinnott (1914) and Bailey (1924, 1944b), (2) the ontogenetic studies of Barghoorn (1940, 1941a, 1941b), (3) the comparative morphological studies of Brown (1918), Vestal (1937), Tippo (1938, 1946) and Bailey (1944b), and (4) studies of correlations with decrease in cell size by Bailey and Tupper (1918), Frost (1930a, 1930b, 1931) and Kribs (1935, 1937).

The descriptive terms employed are based largely on those of the Committee on Nomenclature, International Association of Wood Anatomists (1933); Bailey (1936); Record (1936); Chalk (1937, 1938); Committee on Standardization of Terms of Cell Size, International Association of

Wood Anatomists (1937, 1939); Record and Chattaway (1939); Tippo (1941); Metcalfe and Chalk (1950); and Hess (1950).

Key to measurements. Vessel element length (Committee on Standardization of Terms of Cell Size 1937) Total length on macerated material. N. B., writer also used this table for tracheids.

Extremely short—less than 175 microns
Very short—175–250
Moderately short—250–350
Medium—350–800
Moderately long—800–1100
Very long—1100–1900
Extremely long—over 1900

Vessel element diameter (Committee on Standardization of Terms of Cell Size 1939) Tangential view.

Extremely small—up to 25 microns
Very small—25–50
Moderately small—50–100
Medium—100–200
Moderately large—200–300
Very large—300–400
Extremely large—over 400

Fiber length (Committee on Standardization of Terms of Cell Size 1937)

Extremely short—less than 500 microns
Very short—500–700
Moderately short—700–900
Medium—900–1600
Moderately long—1600–2200
Very long—2200–3000
Extremely long—over 3000

Pit diameter (Record and Chattaway 1939) Longest diameter. N. B., writer also used this table for fiber pits as well as vessel pits.

Minute—less than 4 microns
Small—less than 7
Medium—7–10
Large—over 10
Very large—over 15

Width of vessel perforations (Frost 1930b)

Narrow—up to 6 microns
Wide—over 6 microns

End walls of vessel elements (Arbitrarily devised by writer) Measured from vertical.

Very oblique—up to 30°
Oblique—30°–60°
Slightly oblique—60°–80°
Transverse—80°–90°

Observations and discussion. An analysis of the data obtained[4] reveals the following facts:

1. *Presence or absence of vessels*

	Ranales	Amentiferae	
Primitive:			Ranales more primitive
Vessels absent	12½%	0%	
Advanced:			
Vessels present	87½%	100%	

[4] Detailed tables of data are available in an expanded version of this paper in the Hunter College Library.

2. *Perforation plates*

	Ranales	Amentiferae	
Primitive:			Ranales
Scalariform or predominantly scalariform	65%	23%	more primitive
Advanced:			
Simple or predominantly simple	35%	77%	

Metcalfe and Chalk (1950) list *Fagus* and *Nothofagus* as having predominantly scalariform perforation plates. The writer was not able to reach these conclusions with the material at hand (nine slides of three different specimens of *Fagus grandifolia* and four slides of one specimen of *Nothofagus antarctica*). However, Solereder (1908) points out that in the Fagaceae scalariform perforated vessels are characteristic mostly of regions near the primary wood.

3. *Bars to a plate*

	Ranales	Amentiferae	
Primitive:			Ranales
More than 15 bars	27½%	23%	more primitive
Intermediate:			
Five to 15 bars	36½%	15%	
Advanced:			
Five or less bars	36½%	62%	

4. *Width of perforations*

	Ranales	Amentiferae	
Primitive:			Ranales
Six or less microns	36%	14%	more primitive
Advanced:			
More than six microns	64%	86%	

5. *Perforation plate borders*

	Ranales	Amentiferae	
Primitive:			Ranales
Bordered	36%	5%	more primitive
Advanced:			
Non-bordered	64%	95%	

6. *End walls*

	Ranales	Amentiferae	
Primitive:			Ranales
Very oblique to oblique	64%	50%	more primitive
Intermediate:			
Oblique to slightly oblique	0%	27%	
Advanced:			
Slightly oblique to transverse	36%	23%	

7. *Vessel element length*

	Ranales	Amentiferae	
Primitive:			Ranales
Long	50%	5%	more primitive
Intermediate:			
Medium	36%	63%	
Advanced:			
Short, or short to medium	14%	32%	

The vessel elements of *Himantandra* examined by the writer averaged slightly shorter than the figures given by Brown and Panshin (1940) and

Metcalfe and Chalk (1950). However, if their averages were substituted above, they would tend to augment the general results already obtained.

8. *Vessel element diameter*

	Ranales	Amentiferae	
Primitive:			Ranales more primitive
Small	64⅔%	55%	
Intermediate:			
Small to medium	21⅓%	36%	
Advanced:			
Medium to large	14⅓%	9%	

According to Metcalfe and Chalk (1950) *Schizandra* and *Kadsura* vessel elements average larger diameters than those measured by the writer. However, this would not affect the "primitive" percentages listed above.

9. *Cross-sectional outline of vessels*

	Ranales	Amentiferae	
Primitive:			Ranales more primitive
Angular	42%	10%	
Intermediate:			
Angular to round	42%	25%	
Advanced:			
Oval to round	16%	65%	

10. *Thickness of vessel walls*

	Ranales	Amentiferae	
Primitive:			Ranales more primitive
Very thin—up to 2.5 microns	43%	5%	
Intermediate:			
Thin—2.5 to 4.0 microns	57%	86%	
Advanced:			
Medium to thick—over 4.0 microns	0%	9%	

The writer was not able to discover a table for vessel wall thickness in the literataure. Hence, the above dividing line between "thin" and "thick" walls is arbitrary.

11. *Intervascular pitting*

	Ranales	Amentiferae	
Primitive:			Ranales more primitive
Usually scalariform, scalariform to transitional	36%	5%	
Intermediate:			
Usually transitional, opposite, mixed	50%	18%	
Advanced:			
Alternate, opposite to alternate	14%	77%	

12. *Vessel-parenchyma pitting* (a)

	Ranales	Amentiferae	
Primitive:			Ranales more primitive
Usually scalariform, scalariform to transitional	50%	0%	
Intermediate:			
Usually transitional, opposite, mixed	28⅓%	45%	
Advanced:			
Alternate	21⅓%	55%	

13. *Vessel-parenchyma pitting* (b)

	Ranales	Amentiferae	
Primitive:			Amentiferae
Bordered or half-bordered	8%	9%	more
Intermediate:			primitive
Bordered and simple	33½%	45½%	
Advanced:			
Simple	58½%	45½%	

14. *Diffuse or ring porous*

	Ranales	Amentiferae	
Primitive:			Ranales
Diffuse porous	69%	36½%	more
Intermediate:			primitive
Diffuse porous with a tendency toward ring porosity	23%	45½%	
Advanced:			
Ring porous	8%	18%	

15. *Spiral thickenings*

	Ranales	Amentiferae
Present:	29%	32%
Absent:	71%	68%

Spiral thickenings have been reported in the vessels of *Schizandra* and *Kadsura*, and faint spirals in those of *Himantandra* (Metcalfe and Chalk 1950). The writer was not able to discover them in the material at hand. If these were considered in the above table, the results for the Ranales would then be 50% present and 50% absent.

16. *Pore distribution*

	Ranales	Amentiferae	
Primitive:			Amentiferae
Solitary or predominantly solitary	50%	55%	more
Intermediate:			primitive
Solitary and pore aggregates	43%	9%	
Advanced:			
Pore clusters, rows or multiples	7%	36%	

Although the Amentiferae studied have a slightly greater percentage of species with predominantly solitary pores, note that they also have a markedly greater percentage of species with predominantly aggregate pores.

17. *Relative abundance of tracheids, fiber-tracheids and libriform wood fibers*

	Ranales	Amentiferae	
Primitive:			Ranales
Tracheids most abundant, or both tracheids and fiber-tracheids abundant	25%	0%	more primitive
Intermediate:			
Fiber-tracheids most abundant	69%	73%	
Advanced:			
Libriform wood fibers most abundant	6%	27%	

18. *Tracheid length*

	Ranales	Amentiferae	
Primitive:			Ranales
Long or medium to long	47%	10%	more
Intermediate:			primitive
Medium	33%	75%	
Advanced:			
Short or short to medium	20%	15%	

19. *Fiber length* (fiber-tracheids and libriform wood fibers)

	Ranales	Amentiferae	
Primitive:			Ranales
Long or medium to long	31%	5%	more
Intermediate:			primitive
Medium	25%	27%	
Advanced:			
Short or short to medium	44%	68%	

Metcalfe and Chalk (1950) list the fibers of *Himantandra* in the medium to moderately long category. The fibers of the species examined by the writer were found to be moderately short, but the specimen available was rather young. In any case, moving *Himantandra* from the advanced to the primitive group would not alter, but augment, the conclusion.

20. *Septate fibers*

	Ranales	Amentiferae
Present:	18%	36%
Absent:	82%	64%

The above results regarding septate fibers seem to favor Tippo's (1938) rather than Chalk's (1937) conclusions.

21. *Relative abundance of fiber pits*

	Ranales	Amentiferae	
Primitive:			Ranales
Numerous	56½%	27%	more
Intermediate:			primitive
Few to many	31%	36½%	
Advanced:			
Few	12½%	36½%	

22. *Size of fiber pits*

	Ranales	Amentiferae	
Primitive:			Ranales
Large or medium to large	31%	0%	more
Intermediate:			primitive
Small to large	6½%	0%	
Advanced:			
Small or small to medium	62½%	100%	

Kribs (1927) reports large rather than small fiber pits for *Alfaroa* and *Pterocarya*. Substituting his values in the above tables would not appreciably alter the general results.

23. *Type of fiber pits*

	Ranales	Amentiferae	
Primitive:			Ranales
Bordered	94%	73%	more
Intermediate:			primitive
Bordered and simple	6%	0%	
Advanced:			
Simple	0%	27%	

Metcalfe and Chalk (1950) record only simple fiber pits for *Clematis*. In the two species (*C. dioscoreifolia* and *C. virginiana*) examined by the writer distinct fiber pit borders could be seen.

24. *Type of rays*

	Ranales	Amentiferae	
Primitive:			Ranales
Heterogeneous	100%	45%	more
Intermediate:			primitive
Heterogeneous to homogeneous	0%	32%	
Advanced:			
Homogeneous	0%	23%	

25. *Type of xylem parenchyma*

	Ranales	Amentiferae	
Primitive:			Ranales
Diffuse or predominantly diffuse	37½%	9½%	more
Intermediate:			primitive
Diffuse and aggregate	12½%	62%	
Advanced:			
Aggregate or predominantly aggregate	50%	28½%	

26. *Relative abundance of xylem parenchyma*

	Ranales	Amentiferae	
Primitive:			Ranales
Sparse	62½%	24%	more
Intermediate:			primitive
Medium	37½%	43%	
Advanced:			
Abundant	0%	33%	

27. *Non-stratified or storied wood cells*

	Ranales	Amentiferae	
Primitive:			Amentiferae
Non-storied	93%	100%	more
Advanced:			primitive
Storied	7%	0%	

The writer tried to include representatives of all arborescent ranalian and amentiferous families in the above comparisons. Ranalian families not represented include the Dilleniaceae, Crossosomataceae, Eupteleaceae, Trochodendraceae and Tetracentraceae. However, judging from the works of previous writers (Moll and Janssonius 1906–1936; Thompson and Bailey 1916; Bailey and Thompson 1918; Kanehira 1921a, 1921b, 1924a, 1924b, 1926; Record and Mell 1924; Lecomte 1926; McLaughlin 1928, 1933; Yamabayashi 1936; Record 1943b; Record and Hess 1943; Bailey 1944a; Bailey and Nast 1945a, 1945b, 1946; Metcalfe and Chalk 1950) the inclusion of species from these families would throw the balance even farther in favor of a primitive wood anatomy status for the Ranales.

The following arborescent families, included in the Amentiferae by some botanists, were omitted in this report: Casuarinaceae, Platanaceae, Ulmaceae, Eucommiaceae, Moraceae and Urticaceae. According to previous literature (Moll and Janssonius (1906–1936; Bailey and Sinnott 1914; Jeffrey 1917; Record 1919b, 1934a, 1942, 1943a; Kanehira 1921b; Record and Mell 1924; Chalk and Rendle 1929; Tippo 1938, 1940; Brown and Panshin 1940; Record and Hess 1943; Mosely 1948; Metcalfe and Chalk 1950) species of these families possess specialized wood anatomical struc-

ture and their representation would merely augment the results of this report.

Judging from the material examined, the ranalian species are decidedly more primitive than those of the Amentiferae in 22 out of 25 lines of structural specialization.

Ecological factors cannot be ignored in discussing these results. Bailey (1951) points out that little is known regarding the range of variability of anatomical characters in different parts of individual plants and in different individuals of the same species grown under widely varying environmental conditions. Forsaith (1920) observed simplification of rays in certain plants of the Presidential Range in New Hampshire compared with similar plants grown in more sheltered lowlands. Penfound (1931), studying the effect of soil moisture on vascular development found that, with increasing wetness of soil, the vascular area was greater, the cells were larger, and the mechanical elements were thicker walled and more numerous.

The writer examined a species of dwarf *Salix* from the top of Mount Albert on the Gaspé Peninsula and found that the vessel elements were greatly reduced in length and diameter compared with the generic range. Also, the lateral wall pits of this species have relatively very large, conspicuous borders and the end plates are scalariform rather than simple.

The part played by the age of the specimen and shrinkage must also be taken into consideration. The writer compared a New York Botanical Garden herbarium specimen of the wood of *Ostrya virginiana* collected in 1843 with a similar specimen collected in 1951, and one of *Carpinus caroliniana* collected in 1834 with a comparable sample collected in 1951. There was no apparent difference in xylem element lengths, but the vessel element diameters of the 1834 *Carpinus* were somewhat, but not appreciably, less than those of the 1951 specimen.

To determine whether the size range between young and mature xylem elements would vary enough to affect the results of this report seriously, the writer made a comparison between young and mature wood of the following species: *Magnolia grandiflora, Liriodendron Tulipifera, Cercidiphyllum japonicum, Betula lutea, Carpinus caroliniana, Juglans nigra* and *Castanea dentata* and found that the results were negligible in three year and older twigs. In one and two year old twigs the results were as follows:

	Vessel element length	Vessel element diameter	Fiber length
Magnolia grandiflora	50% shorter	50% narrower	40% shorter
Liriodendron Tulipifera	40% shorter	50% narrower	60% shorter
Cercidiphyllum japonicum	About same	About same	About same
Betula lutea	50% shorter	50% narrower	40% shorter
Carpinus caroliniana	About same	50% narrower	About same
Juglans nigra	About same	About same	40% shorter
Castanea dentata	About same	About same	30% shorter

Therefore, the measurements on *Lactoris fernandeziana, Degeneria vitiensis* and *Balanops australiana* in this report are questionable. However, this would not affect the final conclusions drawn in this report. Differences other than measurements were minor and would not appreciably alter the results.

SUMMARY

1. The old question of the "primitive-or-specialized" status of the "Amentiferae" has been recently revived by the Swedish botanist, Hjelmqvist, who, in a long paper based solely on floral morphology (Hjelmqvist 1948), concludes that they are among the most primitive Angiosperms.

2. Attacking the problem from the point of view of wood anatomy, the writer selected at random 16 species of the recognized primitive order, Ranales, and 22 species of the long-debated group, Amentiferae, and examined their secondary xylem elements.

3. In a percentage comparison based largely on Tippo's criteria of structural evolution arrived at independently of any previously held idea that the Ranales or Amentiferae are primitive (Tippo 1938, 1946), the writer found the latter group to be decidedly more specialized than the former in all but three of 25 lines of specialization. Hence, from the point of view of the wood anatomy of the Amentiferae examined, there is very little to indicate that they are a primitive group.

4. The fibers of *Clematis* examined by the writer have distinctly bordered rather than simple pits as recorded by Metcalfe and Chalk (1950).

5. The perforation plates of *Magnolia grandiflora* have very narrow, complete borders, rather than no borders as recorded by Frost (1930a).

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TWO NEW SPECIES OF PLECTOSPIRA ISOLATED FROM DISCOLORED ROOTLETS

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Only a few members of the Saprolegniaceae have become known as causal agents of damping-off, root rot, and stem rot in phanerogamic crop plants growing in garden or field under ordinary conditions of cultivation. The family was considered almost wholly of aquatic habitat when Peters (1906, 1911) disclosed a saprolegniaceous fungus as a destructive field pathogen in setting forth a species of *Aphanomyces* that he held identical with *A. levis* DeBary as one of the 3 fungi mainly responsible for the black-root disease (Wurzelbrand) widely affecting sugar-beet (*Beta vulgaris* L.) seedlings in Germany. Soon afterwards Barrett (1912) reported that black-root of radish (*Raphanus sativus* L.), a disease he found widely distributed in the United States, was likewise caused by *A. levis*. The radish parasite, which Kendrick (1927) later described as a separate species under the binomial *A. raphani,* has since been found severely attacking many varieties of radish also in Europe (Böning 1932–1933, 1935–1936). The sugar-beet parasite, which from studies on cultures isolated from diseased seedlings in Michigan I presented (Drechsler 1929) as a distinct species under the binomial *A. cochlioides,* has in recent years become troublesome in our humid Middle West not only because of its attack on seedlings but also because of its continued injury to the root system of the host in later stages of growth (Coons, Kotila, and Boekstahler 1946). Very extensive softening of cortical tissues is characteristic of the serious root rot of canning peas (*Pisum sativum* L.) caused in wet seasons by *A. euteiches* (Jones and Drechsler 1925), a fungus Linford (1927) found capable, besides, of severely injuring young seedlings of certain species of *Vicia* and *Lathyrus*. *A. camptostylus* Drechsler (1929), originally described from a culture isolated from an oat (*Avena sativa* L.) root, was found by Sprague (1950) to occur also on diseased roots of *A. byzantina* K. Koch, *Festuca elatior* L., *F. rubra* L., *Setaria viridis* (L.) Beauv., and *Stipa viridula* Trin. Although the cultures on which my description of *A. cladogamus* was based came from tomato (*Lycopersicon esculentum* Mill.) rootlets (Drechsler 1927, 1929), this species seems far more injurious to the pansy (*Viola tricolor* L.) as it causes on that host a severe root rot and crown rot often resulting in death of affected plants (Drechsler 1934). It apparently occurs widely, too, on discolored roots of spinach (*Spinacia oleracea* Mill.) and has

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been isolated (Drechsler 1935) from discolored flax (*Linum usitatissimum* L.) roots. In Canada it has recently been reported (McKeen 1952) as a cause of damping-off in pepper (*Capsicum annuum* L.) seedlings and as being capable of bringing about considerable damping-off in tomatoes, radish, and eggplant (*Solanum melongena* L.). The *Aphanomyces* root rot of eggplant, lettuce (*Lactuca silva* L.), and pepper seedlings earlier observed by Mix (1945) in New Jersey may have been caused by the same fungus.

Apart from the 5 species of *Aphanomyces* just enumerated 2 root-inhabiting saprolegniaceous fungi, one isolated from discolored tomato rootlets and the other from sugar-cane (*Saccharum officinarum* L.) roots, have been described under the binomials *Plectospora myriandra* Drechsler (1927) and *P. gemmifera* Drechsler (1929), respectively. In these two fungi the zoosporangia are not formed directly from outwardly unmodified portions of mycelium, as in *Aphanomyces*, but consists of irregularly distended hyphal branches which sometimes are compounded into massive clews visible to the naked eye. While in all root-inhabiting species of *Aphanomyces* the oogonia are supplied with antheridia in numbers ranging usually from 1 to 5, in *P. myriandra* these organs either develop without any antheridia whatever or, as always in *P. gemmifera*, are beset with dozen of antheridial elements. Similar association of distended zoosporangia with oogonia either wholly parthenogenetic or very abundantly mated—an association without a counterpart among species of *Pythium* having sporangia of lobulate type—is found also in two delicate saprolegniaceous fungi that came to light in a varied assortment of cultures isolated from roots of herbaceous plants near Beltsville, Maryland, early in the autumn of 1950, after liberal rains and prolonged cloudiness had provided conditions favorable for root disease. As these two fungi differ from both *P. myriandra* and *P. gemmifera* they are described herein as new members of the same genus.

1. **Plectospira agama** Drechsler sp. nov. Mycelium incoloratum, mediocriter ramosum, in materiis alibilibus mollibus tepidis (25° C.) circa 18 mm. radiatim in die crescens; hyphis sterilibus vulgo 1.5–6 μ latis; zoosporangiis incoloratis, simplicibus vel ramosis, 5–20 μ latis, ubi simplicibus vel parum ramosis ibi vulgo pansis, ubi copiose ramosis ibi saepe valde glomeratis, tubo exinanitionis vulgo 50–500 μ longo apice 2–5 μ lato praeditis, plerumque 25–300 zoosporas gignentibus; zoosporis in statu immobili globosis, saepius 8–11 μ crassis, protoplasma eorum per tubulum circa 2.3 μ latum et 0.6 μ longum saepe emittentibus, in statu agili reniformibus, latere 2 ciliis instructis; chlamydosporis globosis, saepius 25–40 μ crassis; oogoniis in apice ramulorum lateralium singulatim oriundis, globosis, plerumque 19.5–26.5 μ (saepe circa 22.8 μ) crassis, sine antheridiis, unam parthenosporam gignentibus; ramulis oogonialibus rectis vel flexuosis 5–100 μ (plerumque 5–40 μ) longis, basi saepe 1.5–3 μ latis, apice 2.5–5 μ latis; parthenosporis incoloratis, globosis, plerumque 16.3–23.4 μ (saepius circa 20.3 μ) crassis, membrana plerumque 1.1–1.6 μ crassa praeditis, unam pilulam oleosam plerumque

9.5–13.5 μ (saepius circa 11.5 μ) crassam et unum corpusculum nitidum applanato-ellipsoideum continentibus.

Habitat in radicibus *Prunellae vulgaris* putrescentibus prope Beltsville, Maryland.

Mycelium colorless, moderately branched, in soft nutrient materials at temperatures near 25° C. growing radially about 18 mm. in 24 hours, composed of hyphae mostly 1.5 to 6 μ wide; zoosporangia colorless, 5 to 20 μ wide, simple or unbranched, when simple or only meagerly branched most often fully extended, when copiously branched more frequently gathered into a somewhat massive clew, in either case provided with a tapering evacuation tube commonly 50 to 500 μ long and 2–5 μ wide at the tip, producing 25 to 300 zoospores; encysted zoospores globose, mostly 8 to 11 μ in diameter, often discharging their protoplasm through an evacuation tube about 2.3 μ wide and 0.6 μ long to give rise individually to a reniform, laterally bicilliate, motile swarm-spore; chlamydospores globose, often 25 to 40 μ in diameter; oogonial branches straight or somewhat curved, 5 to 100 μ (mostly 5 to 40 μ) long, often 1.5 to 3 μ wide at the proximal end and 2.5 to 5 μ wide distally; oogonia formed terminally, colorless, globose (though often including a cylindrical proximal part up to 10 μ in length), mostly 19.5 to 26.5 μ (average 22.8 μ) in diameter, developing without antheridia in forming a single parthenospore; parthenospores colorless, globose, mostly 16.3 to 23.4 μ (average 20.3 μ) in diameter, provided with a wall 1.1 to 1.6 μ thick, containing a single reserve globule mostly 9.5 to 13.5 μ (average 11.5 μ) in diameter, and having imbedded in the parietal layer a single refringent body frequently of oblate ellipsoidal shape, about 4.2 μ wide and 2 μ thick.

Isolated from decaying roots of *Prunella vulgaris* L. collected near Beltsville, Maryland, on September 26, 1950.

As separate cultures of *Plectospira agama* were isolated from the roots of several selfheal plants that were taken up in scattered positions in open woods on well drained upland, the fungus may occur more or less habitually on that familiar herb. Growing in maizemeal-agar plate cultures its mycelium has a radiating appearance not markedly different from the appearance of *Plectospira myriandra* and *P. gemmifera*. Asexual reproduction can usually be obtained in some measure by transferring sizable slabs of maizemeal agar well permeated with young mycelium to a shallow layer of distilled water. More copious development of zoosporangia generally ensues when slabs excised from young Lima-bean agar cultures are judiciously irrigated. On the richer substratum numerous zoosporangia (fig. 1, A–F) are formed in 36 hours, their production being especially abundant along the margins of the slabs. In the formative stages of their development they are filled throughout with granular protoplasm, but after they have been delimited proximally by a cross-wall and are extending a long evacuation tube (fig. 1, F, t) they become conspicuously vacuolate. The granular material is rearranged into chains of young zoospores which soon are rapidly discharged through the open tip of the evacuation tube. They encyst immediately, thus forming a cluster near the orifice. A little later their

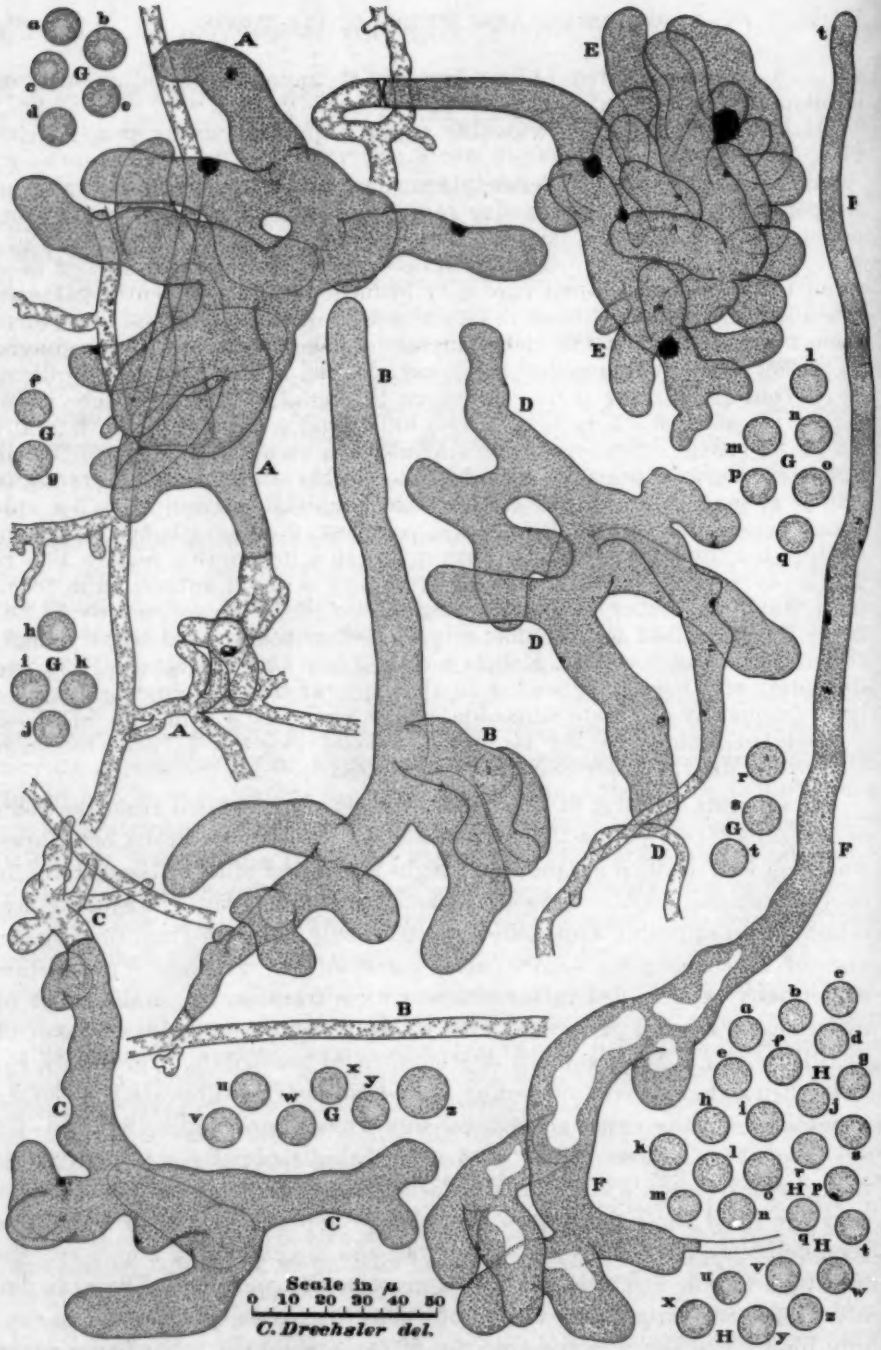


FIG. 1. *Plectospira agama*, as found developing on slabs excised from a Lima-bean agar plate culture and transferred to a shallow layer of water; ×500 throughout. A-E, Young zoosporangia delimited from mycelium. F, Zoosporangium with evacuation tube, t. G (a-z), H (a-z), Encysted zoospores.

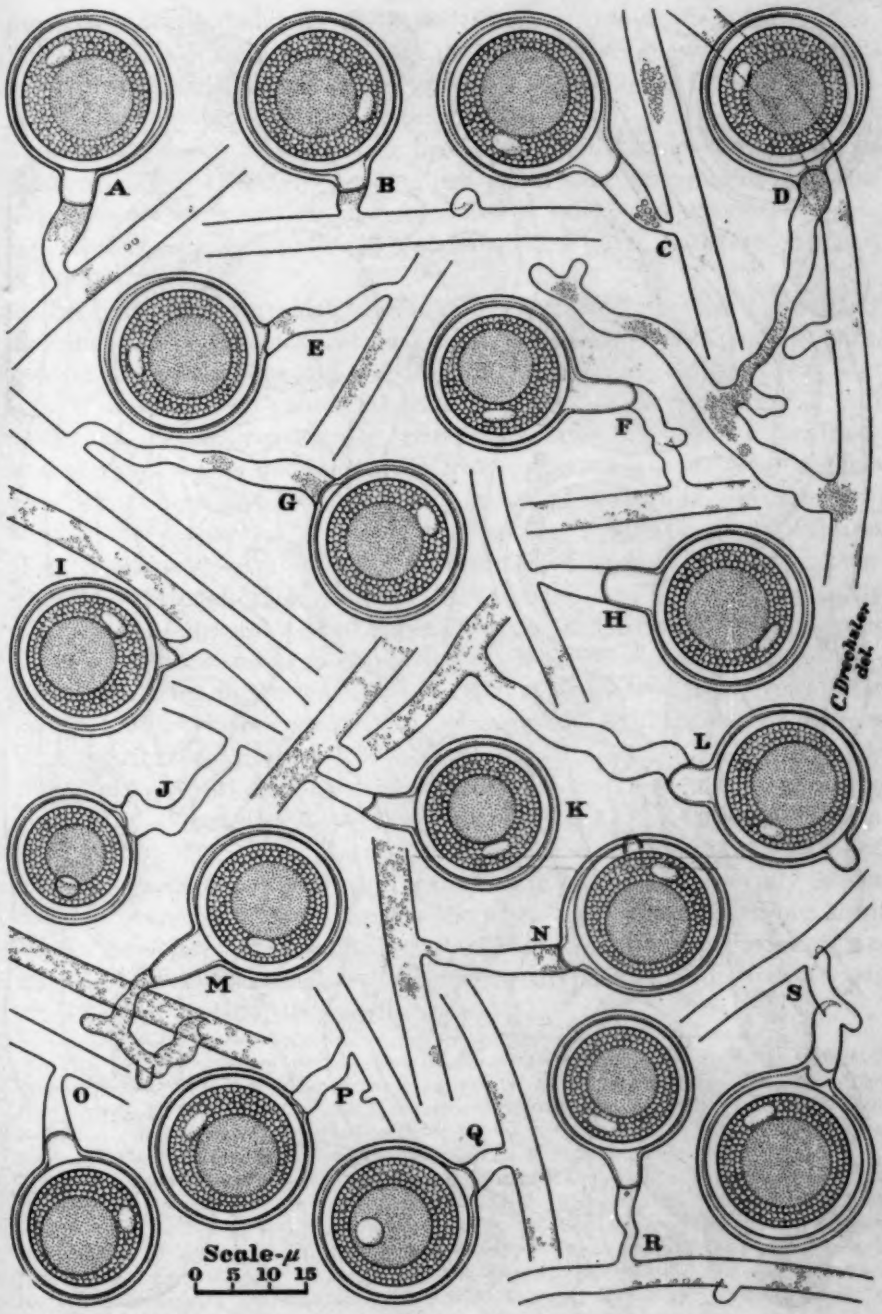
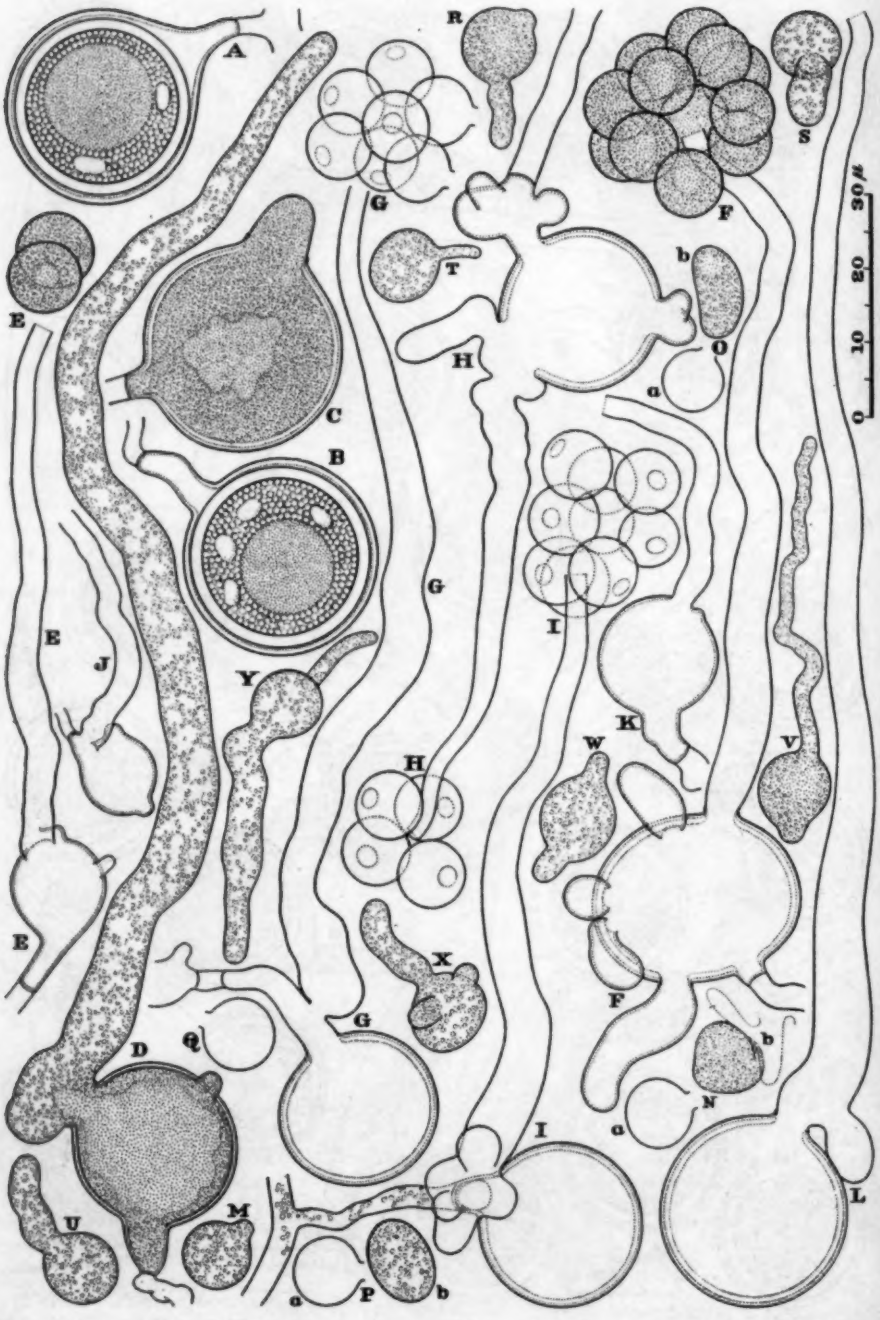


FIG. 2. *Plectospira agama*, as found in a maizemeal-agar plate culture 7 days old; ×1000 throughout. A-S, Portions of mycelium, each with an oogonium containing a mature parthenospore.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protoplasts flow out and are converted externally into motile swarm-spores. After swimming about for some time the swarm-spores encyst again. In irrigated preparations 2 days old encysted zoospores (fig. 1, G, a–z; H, a–z) are usually present in countless numbers.

Chlamydospores of globose or prolate ellipsoidal shape are sometimes produced rather sparingly in aging maizemeal agar cultures. Though possibly homologous with the chlamydospores or gemmae of *Plectospira gemmifera*, they seem to represent only a subsidiary phase in the development of the fungus.

Reproduction equivalent to sexual reproduction takes place promptly and abundantly in maizemeal agar containing some finely divided maizemeal in suspension. Oogonia are soon formed in large numbers. As is suggested in the specific epithet, they have never been found supplied with antheridia. Their consistently parthenogenetic development contrasts strongly with sexual development in *Plectospira gemmifera*, where oogonia have always been found supplied with numerous antheridia. Since the parthenogenetic apparatus produced copiously in maizemeal agar cultures shows a relatively high degree of uniformity with respect to shape, dimensions, and internal organization (fig. 2, A–S), it may be considered fairly typical of the species. Accordingly, 100 units of such apparatus, taken at random, were measured to obtain the metric data on oogonium and parthenospore given in the diagnosis. The 100 oogonia gave measurements for diameter which when expressed in the nearest integral number of microns were distributed as follows: 20 μ, 4; 21 μ, 8; 22 μ, 26; 23 μ, 30; 24 μ, 24; 25 μ, 5; 26 μ, 2; 27 μ, 1; while the parthenospores in them gave measurements for diameter distributed thus: 16 μ, 1; 18 μ, 1; 19 μ, 20; 20 μ, 35; 21 μ, 28; 22 μ, 11; 23 μ, 4. By searching for specimens of unusually small and unusually large dimensions some oogonia only 16 μ and others fully 30 μ in diameter were found; the parthenospores in the former measuring about 14 μ in diameter, and those in the latter about 27 μ. Smaller dimensions are usual in irrigated material, where oospores only about 10 μ in diameter can often be found with little search.

FIG. 3. Parthenospore germination in *Plectospira agama*, as found in irrigated preparations of material taken from a maizemeal agar culture 3 months old; ×1000 throughout. A, B, Parthenospores that show after-ripening in their plural refringent bodies—a condition reached before transfer to water. C, Parthenospore with short germ hypha. D, Parthenospore with long germ hypha. E, F, Empty parthenospores from which 2 and 12 zoospores, respectively, have been discharged. G-I, Empty parthenospores, each with empty globose zoospore envelopes clustered at the mouth of its evacuation tube. J-L, Empty parthenospores, each with empty evacuation tube. M, Encysted zoospore with papilla of dehiscense. N, Empty zoospore envelope, a, and the motile zoospore, b, that emerged from it. O, P, Empty zoospore envelopes, a, each with a secondary zoospore, b, that has encysted near the open evacuation tube. Q, Evacuated zoospore envelope. R-Y, Encysted zoospores germinating by emission of 1 to 3 germ tubes.

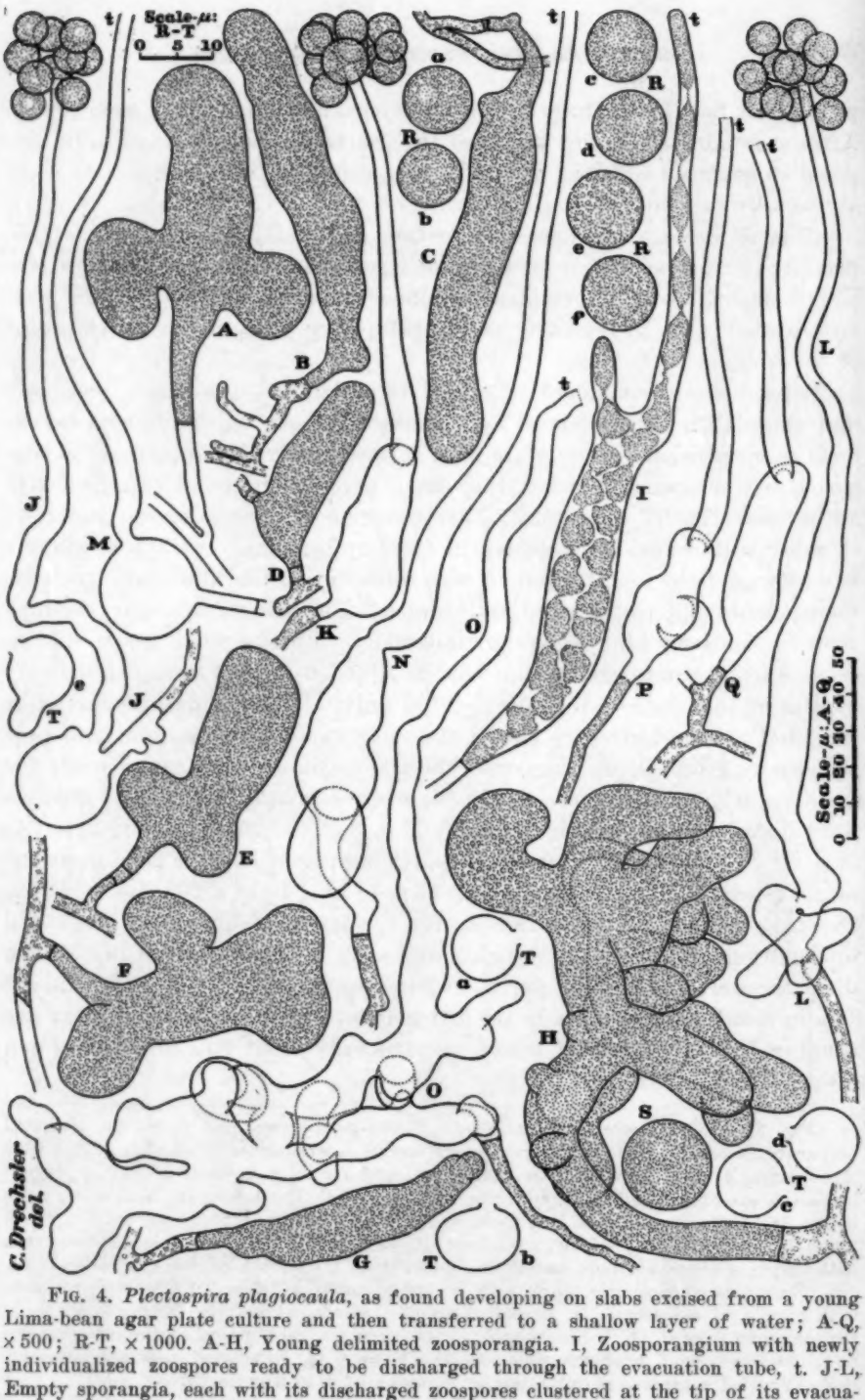
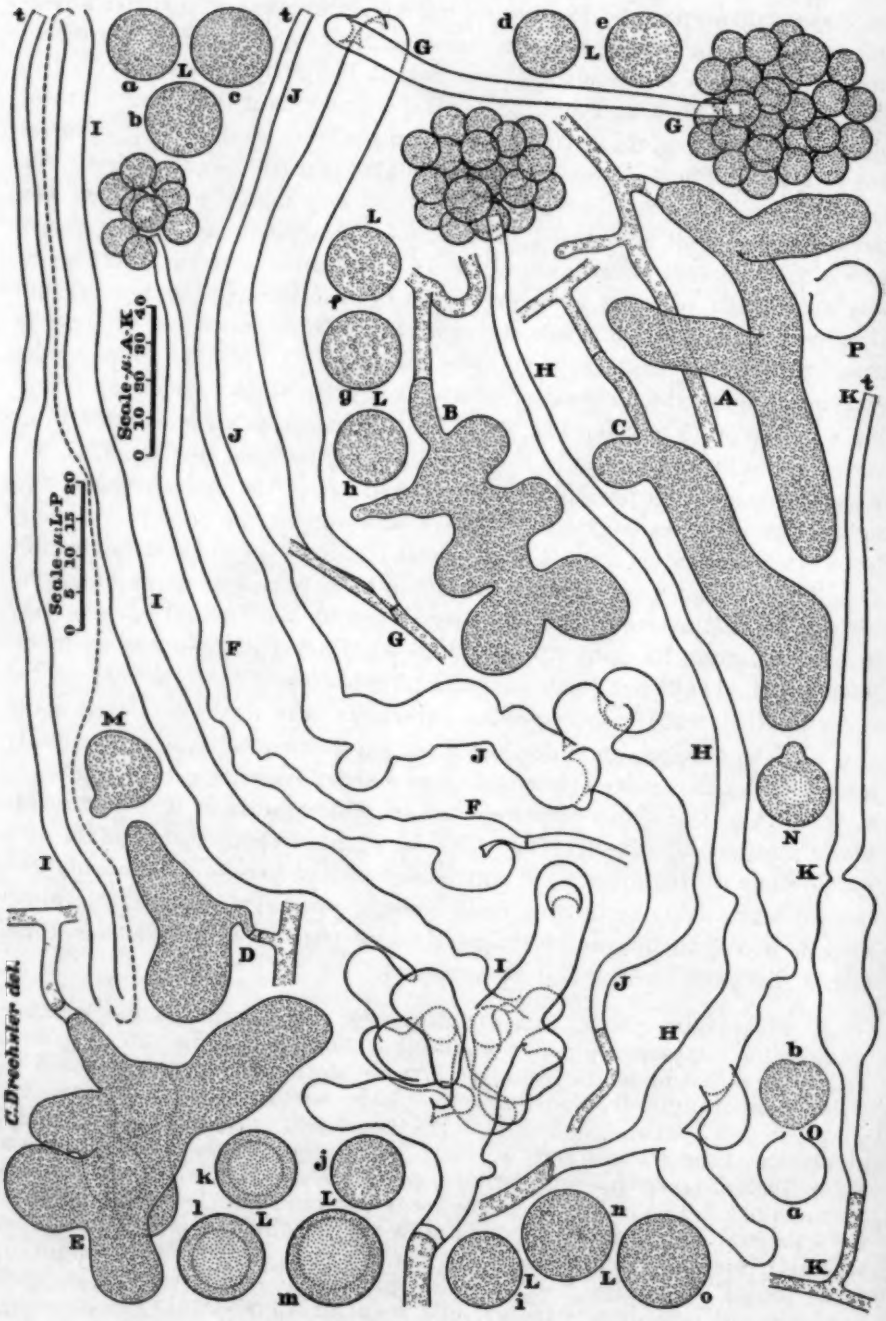


FIG. 4. *Plectospira plagiocaula*, as found developing on slabs excised from a young Lima-bean agar plate culture and then transferred to a shallow layer of water; A-Q, × 500; R-T, × 1000. A-H, Young delimited zoosporangia. I, Zoosporangium with newly individualized zoospores ready to be discharged through the evacuation tube, t. J-L, Empty sporangia, each with its discharged zoospores clustered at the tip of its evacuation tube. M-Q, Empty sporangia, each with empty evacuation tube, t. R, Encysted zoospores a-f, of usual size. S, Unusually large encysted zoospore. T, Evacuated envelopes of zoospores, a-e, left after completion of repetitional development.

The parthenospores of *Plectospira agama* germinate readily after a resting period of 3 months. Successive stages in after-ripening are often recognizable earlier as the number of refringent bodies increases first to two (fig. 3, A) and then to four (fig. 3, B). Further multiplication of these bodies is obscured as the parietal layer changes from a minutely globuliferous to a more opaque, promiscuously granular texture. Simultaneously the reserve globule becomes irregular in outline and diminishes in size. The parthenospore wall is reduced in thickness throughout its circumference, owing to resorption of an inner layer. In a restricted area the outer layer, too, is dissolved, permitting the protoplast to push through the opening and then in like manner to break through the oogonial envelope, so that its broad protrusion erupts as a germ hypha (fig. 3, C). If the germ hypha encounters pure water devoid of nutrients it often stops growing on reaching a length of 25 to 200 μ (fig. 3, D) and functions as an evacuation tube, with the discharged zoospores rounding up near its open tip (fig. 3, E, F). After the individual protoplasts have flowed out of the cyst envelopes and have swum away as laterally biciliate swarm-spores, the empty cyst envelopes often remain visible in a cluster near the orifice of the evacuation tube (fig. 3, G–I). Later, when these envelopes have floated away or have evanesced, the distinctive function earlier served by the evacuation tube may be inferred from its open tip (fig. 3, J–L). Encysted zoospores, as in related fungi, always put forth a papilla of dehiscense (fig. 3, M) before discharging their contents to develop externally into a motile swarm-spore (fig. 3, N, b); the proximal portion of the papillary membrane subsequently appearing on the empty cyst envelope as a short evacuation tube (fig. 3, N, a; O, a; P, a; Q). Under somewhat unfavorable conditions liberated protoplasts may encyst directly (fig. 3, O, b; P, b) without intervention of a motile stage. In the presence of nutrients encysted zoospores commonly germinate vegetatively by putting forth a single germ hypha of variable width (fig. 3, R–V), though not infrequently two (fig. 3, W, Y) or even three (fig. 3, X) germ hyphae may be extended.

2. **Plectospira plagiocaula** Drechsler sp. nov. Mycelium incoloratum, mediocriter ramosum, in materiis alibilibus mollibus tepidis (25° C.) circa 17.5 mm. radiatim in die crescens; hyphis sterilibus plerumque 1.5–6.5 μ latis; zoosporangiis incoloratis, 5–25 μ latis, simplicibus vel ramosis, ubi simplicibus vel parum ramosis ibi vulgo pansis, ubi copiose ramosis ibi saepe glomeratis, tubo exinanitionis 50–600 μ longo apice 2.8–4.5 μ lato praeditis, vulgo 10–200 zoosporas gignentibus; zoosporis in statu immobili globosis, plerumque 8.5–11.5 μ crassis, protoplasma per tubulum circa 2.3 μ latum et 0.6 μ longum emittentibus, in statu agili reniformibus et latere 2 ciliis instructis; ramulis oogonialibus rectis vel flexuosis, 5–100 μ (plerumque 5–60 μ) longis, basi saepe 2–3.5 μ latis, apice 3–6 μ latis; oogoniis in apice horum ramulorum singulatim oriundis, saepe in latere aliquid oblique aptis,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interdum sine antheridiis interdum 20–50 antheridiis praeditis, ubi antheridiorum expertibus ibi plerumque 23–29 μ (saepe circa 26 μ) crassis, ubi antheridiis praeditis ibi saepe 24–36 μ crassis, unam parthenosporam vel unam oosporam gignentibus; antheridiis ex ramis aliarum hypharum oriundis, rectis vel saepius curvatis, plerumque 8–20 μ longis, 2.5–7.5 μ latis, saepe cassis; parthenosporis incoloratis, globosis, plerumque 20–27 μ (saepe circa 23.2 μ) crassis, muro 1.3–1.9 μ crasso circumdatis, pilulam oleosam 11.2–15.7 μ crassam et corpus nitidum ellipsoideum circa 4.5 μ latum 2 μ crassum continentibus; oosporis (oogoniorum antheridiis junctorum) globosis, plerumque 21–34 μ crassis, muro 1.4–2 μ crasso circumdatis.

Habitat in radicibus Rumicis acetosellae putrescentibus prope Beltsville, Maryland.

Mycelium colorless, moderately branched, in soft nutrient materials at temperatures near 25° C. growing radially about 17.5 mm. in 24 hours, composed of hyphae mostly 1.5 to 6.5 μ wide; zoosporangia colorless, 5 to 25 μ wide, simple or branched, when simple or meagerly branched most often fully extended, when more richly branched often compacted into an irregular clew, in any case provided with an evacuation tube 50 to 600 μ long and 2.8 to 4.5 μ wide at the tip, commonly producing 10 to 200 zoospores; encysted zoospores globose, mostly 8.5 to 11.5 μ in diameter, their protoplasts often flowing out individually through an evacuation tube about 2.3 μ wide and 0.6 μ long to become converted externally into a laterally biciliate reniform swarmspore; oogonial branches nearly straight or somewhat flexuous, 5 to 100 μ (mostly 5 to 60 μ) long, often 2 to 3.5 μ wide and 3 to 6 μ wide distally, often attached to the single terminal oogonium laterally rather than mesially; oogonia globose (though often including a cylindrical proximal part up to 10 μ in length), sometimes without antheridia and then measuring mostly 23 to 29 μ (average 26 μ) in diameter, at other times supplied with 20 to 50 antheridia and then usually 24 to 36 μ in diameter, producing a single parthenospore or oospore; antheridia borne on branches from hyphae not closely connected with the hypha bearing the oogonial branch, straight or more often curved, mostly 8 to 20 μ long and 2.5 to 7.5 μ wide, often nonfunctional; parthenospores colorless, globose, mostly 20 to 27 μ (average 23.2 μ) in diameter, surrounded by a wall 1.3 to 1.9 μ thick, containing a reserve globule 11.2 to 15.7 μ in diameter, and having imbedded in the parietal layer a refringent body mostly of oblate ellipsoidal shape, about 4.5 μ wide and 2 μ thick; oospores (in oogonia supplied with antheridia) somewhat larger than the parthenospores, mostly 21 to 31 μ in diameter, surrounded by a wall 1.4 to 2 μ thick.

Isolated from softened discolored roots of *Rumex acetosella* L. collected near Beltsville, Maryland, on October 17, 1950.

FIG. 5. *Plectospira plagiocaula*, as found developing on slabs excised from a young Lima-bean agar plate culture and then transferred to a shallow layer of water; A-K, ×500; L-P, ×1000. A-E, Young delimited zoosporangia. F-H, Empty zoosporangia, each with its progeny of zoospores clustered at the tip of its evacuation tube. I-K, Empty zoosporangia, each with empty evacuation tube, t. (Owing to lack of space the evacuation tube in I is shown in 2 parts whose proper connection is indicated by a broken line.) L, Encysted zoospores among which some (a-l) are of usual size, while others (m-o) are of larger than usual size. M, N, Encysted zoospores, each with papilla of dehiscense. O, Empty envelope of encysted zoospore, a, with naked protoplast, b, that emerged from it. P, Evacuated envelope of encysted zoospore remaining after completion of repetitional development.

More than a dozen cultures of *Plectospira plagiocaula* were obtained from separate sheep-sorrel plants taken up from scattered positions in a moist grassy field about 2 kilometers from the woods where the selfheal specimens harboring *P. agama* had been obtained earlier. Its prompt and frequent appearance in isolation plate cultures indicated that locally, at least, the fungus was present on the underground parts of the host in considerable quantity.

When *Plectospira plagiocaula* is cultured on maizemeal agar its mycelium grows with about the same rapidity as mycelium of *P. agama*. The two species show little difference either in the dimensions or in the branching habit of their vegetative hyphae. By excising from young plate cultures of *P. plagiocaula* sizable slabs of maizemeal or Lima-bean agar well permeated with mycelium, and transferring them to a shallow layer of water, zoosporangia are obtained, as a rule, in lesser quantity than in similarly treated material of *P. agama*. Although the swollen hyphal branches are sometimes a little wider in *P. plagiocaula* than in *P. agama*, they are frequently shorter and less extensively branched (fig. 4, A–G; fig. 5, A–E). Sporangia with a mulberry-like arrangement of swollen parts (fig. 4, H) are generally less massive and less abundant in *P. plagiocaula* than in *P. agama, P. myriandra,* or *P. gemmifera*. Internal development proceeds in *P. plagiocaula* much as in related species, plural chains of young zoospores being formed in the distended parts and a single chain in the narrowing evacuation tube (fig. 4, I, t). After the apex of the evacuation tube has yielded, the naked zoospores are rapidly discharged. They immediately encyst in a cluster near or around the open tip (fig. 4, J–L; fig. 5, F–H). Since discharge here, as also in the 3 congeneric species, takes place exclusively by way of a single terminal orifice the empty evacuation tubes (fig. 4, M–Q: t; fig. 5, I–K: t) never show any supplementary lateral openings like those observable in *Aphanomyces camptostylus* and *A. cladogamus*. The encysted zoospores (fig. 4, R, a–f; fig. 5, L, a–l) mostly differ rather little in size, but as in many other oomycetes scattered individuals of about twice the usual volume (fig. 4, S; fig. 5, L, m–o) give evidence of imperfect cleavage. A papilla of dehiscense put forth by the encysted zoospore (fig. 5, M, N) leaves a short evacuation tube on the empty subspherical membrane (fig. 4, T, a–e; fig. 5, O, a; P) after the protoplasmic contents have streamed out to collect in a globose mass (fig. 5, O, b) ready for transformation into a laterally biciliate motile swarm-spore.

In Petri plate cultures prepared with maizemeal agar containing some finely divided maizemeal in suspension *Plectospira plagiocaula*, like *P. myriandra*, often displays abundantly both types of sexual reproduction known in the genus. Unmated oogonia (fig. 6, A–O) develop more especially in the clearer portions of substratum, at some little distance from the larger

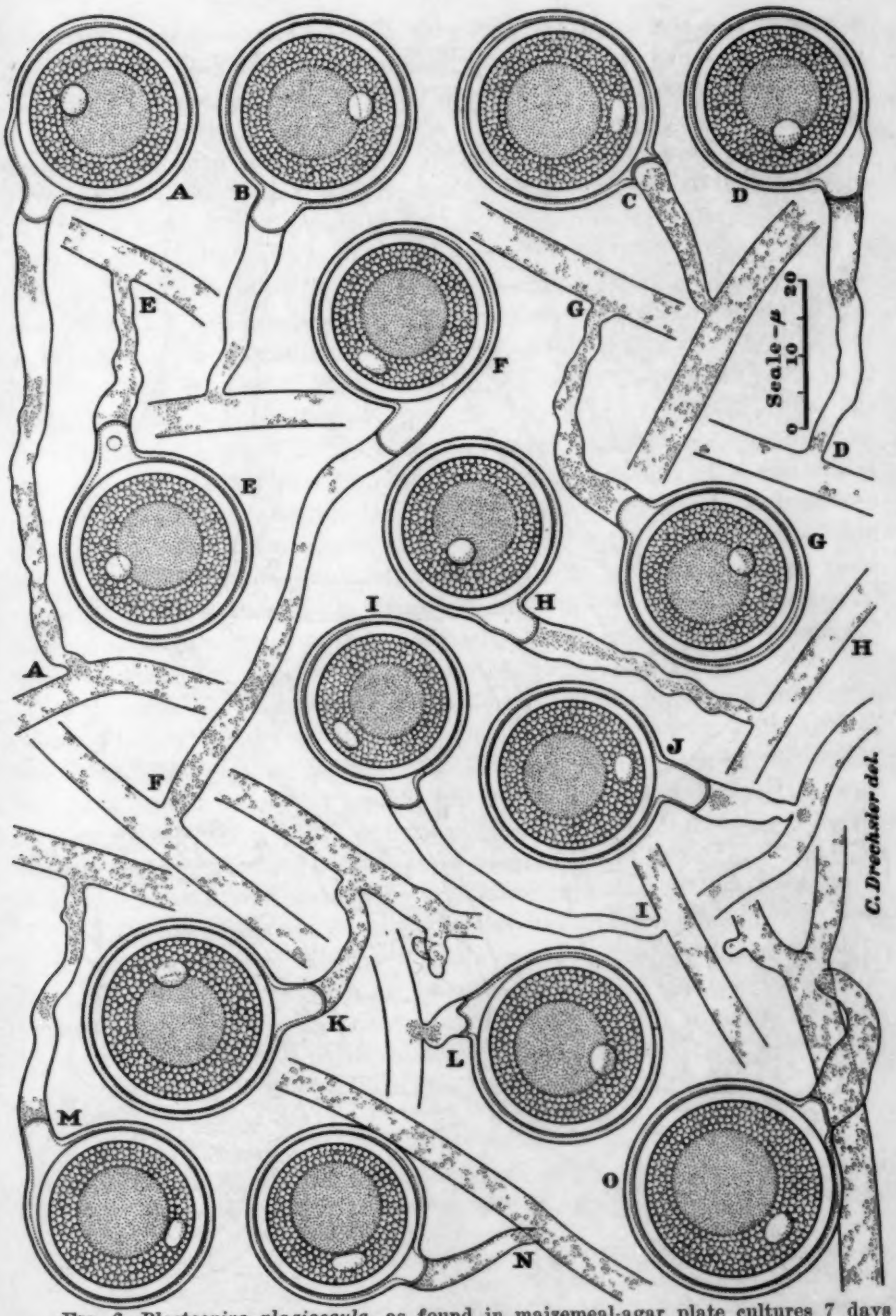

FIG. 6. *Plectospira plagiocaula*, as found in maizemeal-agar plate cultures 7 days old; ×1000 throughout. A-O, Portions of mycelium, each with an oogonium containing a mature parthenospore.

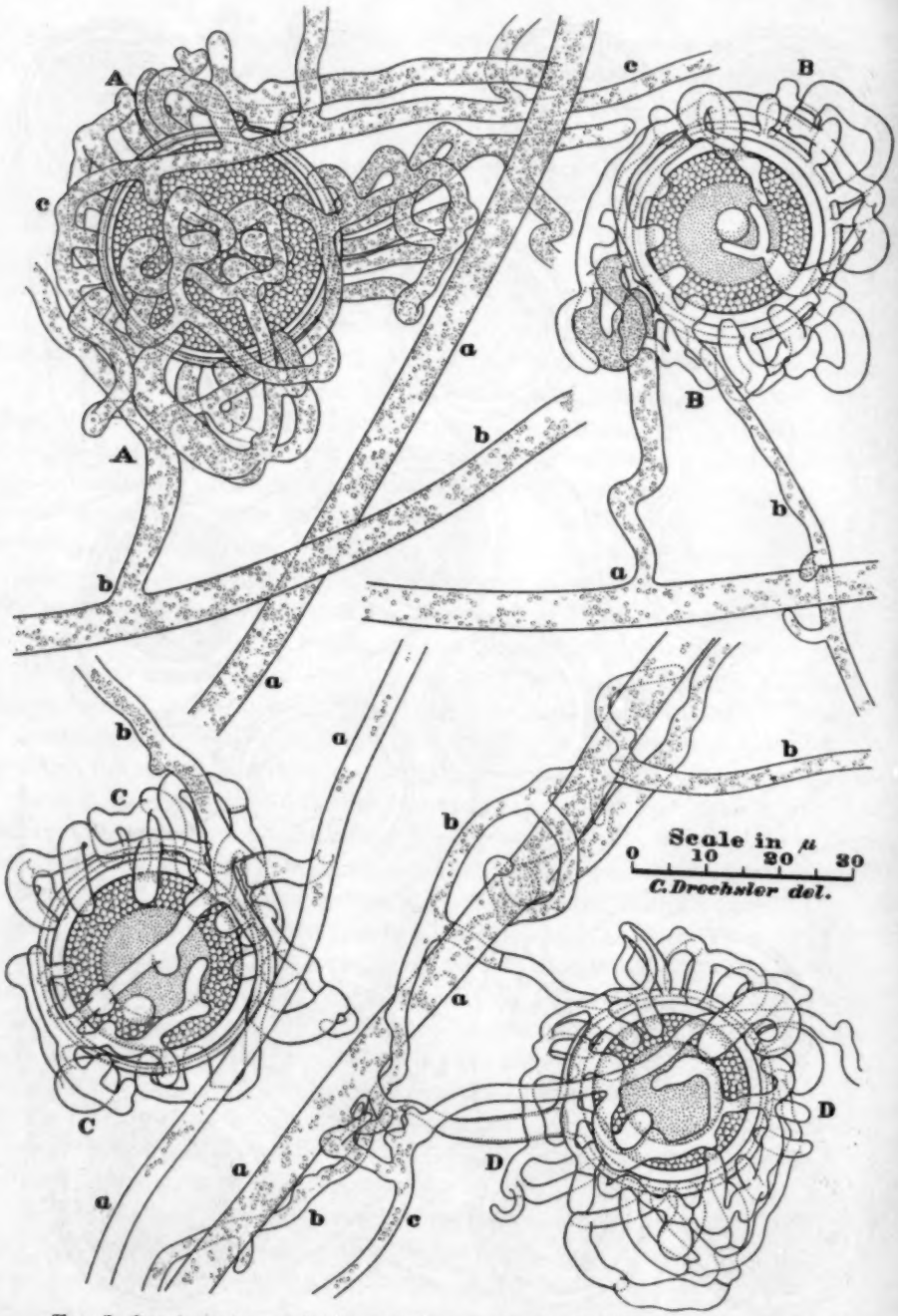

FIG. 7. One immature unit (A) and three mature units (B-D) of sexual apparatus of *Plectospira plagiocaula:* a, hypha bearing oogonial branch; b, c, hyphae bearing antheridial branches; ×1000 throughout.

deposits of maizemeal particles. As they frequently are attached somewhat laterally rather than mesially (fig. 6, A, D, F, H, L, M) they often present a distinctive appearance which it is intended to signalize conveniently in the Theophrastan term used as specific epithet. In maizemeal agar cultures where they develop promptly and abundantly the unmated oogonia and the parthenospores show a high degree of uniformity in their dimensions and exceedingly little departure from correct internal structure. The metric data relating to them in the diagnosis are based on measurements of 100 specimens taken at random in such cultures. The 100 unmated oogonia gave values for diameter, expressed in the nearest integral number of microns, with a frequency distribution as follows: 23 μ, 3; 24 μ, 13; 25 μ, 21; 26 μ, 33; 27 μ, 16; 28 μ, 9; 29 μ, 5; while the parthenospores in them gave values for diameter distributed thus: 20 μ, 2; 21 μ, 5; 22 μ, 19; 23 μ, 33; 24 μ, 24; 25 μ, 9; 26 μ, 7; 27 μ, 1. By searching larger areas of substratum some unmated oogonia were found with a diameter of only 17 μ, and others with a diameter as large as 34 μ; the smallest parthenospores measured about 15 μ across and the largest about 31 μ. Among the relatively small and rather variable oogonia produced haphazardly in irrigated material some contained parthenospores only about 10 μ in diameter. In irrigated material many globose enlargements that manifestly have originated as oogonia are found eventually to develop as zoosporangia (fig. 4, J, M).

In maizemeal agar cultures oogonia abundantly supplied with antheridia commonly develop in very intricate clusters around scattered deposits of maizemeal particles. The filament (fig. 7, A–D: a) that gives off the branch bearing a mated oogonium usually has no close mycelial connection with the hypha (fig. 7, B, b; C, b) or hyphae (fig. 7, A, b, c; D, b, c) bearing the concomitant antheridia. In *Plectospira plagiocaula*, much as in *P. myriandra*, oogonia beset with antheridia are slower in maturing, more subject to internal degeneration, more variable in size, and generally somewhat larger than unmated oogonia. With some little search mated oogonia as much as 39 or 40 μ wide, and containing oospores 35 or 36 μ in diameter, can be found in cultures wherein dimensions, on the whole, may be fairly uniform. Its large oogonia, parthenospores, and oospores distinguish *P. plagiocaula* as the most robust of the 4 known members of the genus.

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NEW TAXA IN THE GENUS DIPLOSTEPHIUM

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In examining various collections of Andean Compositae I have recognized the several new species and forms which are described in this article. These plants are from Peru, Ecuador, and Colombia and were collected by R. Metcalf, F. Woytkowsky, R. Espinosa, F. R. Fosberg, M. Grant and myself. I have received most of the plants here mentioned from the National Arboretum, Smithsonian Institution, New York Botanical Garden and University of California at Berkeley; for the most part, type material is deposited in the Herbarium of the Chicago Natural History Museum. This work has been sponsored by the J. S. Guggenheim Memorial Foundation of New York.

Diplostephium crassifolium Cuatr., sp nov. Frutex ramis tortuoso-erectis griseis plus minusve fuliginosis, ramulis terminalibus crasse denseque tomentosis terminationibus dense foliosis.

Folia brevia alterna integra valde crassa coriacea. Petiolus 2–4 mm. longus crassiusculus supra subplanus basi ampliatus compresse lanato-tomentosus. Lamina rotundato-elliptica vel obovata vel elliptica apice rotundata interdum retusa basi rotundata vel obtusa margine integra vel anguste revoluta, 10–20 mm. longa, 9–14 mm. lata; supra viridia, in sicco plus minusve olivacea, glabra nitida costa impressa superficie leviter rugoso-reticulata; subtus crasse denseque ochraceo-lanato-tomentosa tantum costa crassa conspicua.

Capitula radiata terminalia solitaria sessilia folia superiora subrosulata subaequilonga suffulta, circa 2.5 cm. diam. (cum radiis). Involucrum cupulare 7.8 mm. altum tenue tomento intricato-arachnoideo munitum, circa 5 seriebus bracteis crasse paleaceis uninervis, exterioribus brevioribus lanceolatis acutis, interioribus linearibus acutis 7 mm. longis 1–12 mm. latis, plus minusve decidue lanato-araneosis. Receptaculum crassum 3 mm. diam. profunde alveolatum marginibus alveolorum crasse membranaceis grosse dentatis dentibus circa 0.3 mm. altus centro minoribus. Flores radii feminei ligulati circa 40, corolla alba glabra circa 8 mm. longa tubulo 3.2 mm. longo crassiusculo lamina crassiuscula 1.5 mm. lata apice breviter 3-dentata; ramis styli lanceolato-linearibus glabris; ovarium 1.8 mm. longum subcompressum striatum villosum et sparse glandulosum; pappus 5 mm. longus setis hispidulo-pennatis apice satis ampliatis exterioribus brevioribus angustioribus. Flores centrales hermaphroditi tubulosi circa 30, corolla crasse tubulosa 5.5 mm. longa parce hispidula tubulo 2 mm. longo apice 5-dentata dentibus oblongis circa 1 mm. longis; anthera 2 mm. longae sagittatae; rami stigmatici lineares crassiusculi intus plani pubescente-papillosi 1.2 mm. longi; ovarium villosum et sparse glandulosum praesumpte sterile, pappus feminorum flores similis.

TYPUS: Colombia, Dep. Magdalena: Sierra de Perijá, 12 km. east-ne of Manaure, 48 km. east of Valledupar, 1 km. from the Venezuelan border,

Páramo 3000 m. alt. Heads white. Collect. 5 febr. 1945 Martin L. Grant 10865. (NA).

D. crassifolium belongs to the Sect. *Bifidum* Cuatr. and to the Series *Lavandulifolia* Blake and is distinguished from all the other species by its thick, coriaceous, subelliptical leaves which are densely woolly beneath, and by its comparatively large, sessile solitary heads subtended by the subrosulate superior leaves of the branchlets. The central flowers probably are sterile. It is a unique form in the genus.

Diplostephium espinosae Cuatr., sp. nov. Frutex ramulis griseis tortuosis crispo-lanatis ramis denique glabrescentibus cicatricosis.

Folia parva alterna simplicia petiolo 2–4 mm. longo plano adpresso basi vaginato persistenti puberulo. Lamina coriacea subelliptica 3.5–10 mm. longa, 2–6 mm. lata basi obtusa vel cordata apice calloso-acutiuscula saepe mucronulata, margine revoluta; supra glabra minute rugulosa (in sicco) nitida tantum nervo medio plusminusve depresseque conspicuo, subtus dense albo vel cinereo crispo-lanata, costa plusminusve prominula ceteris nervis invisibilibus.

Capitula radiata terminalia solitaria mediocria subpedunculata. Involucrum campanulatum 7–8 mm. altum circa 5 mm. diam. bracteis 4 seriatis subpaleaceis linearibus, exterioribus brevibus albo-arachnoideo-lanatis obtusinsculis, interioribus angustioribus acutis longioribusque minus lanatis 6–6.5 mm. longis 1–1.2 mm. latis. Flores radii feminei ligulati circa 12, corolla lilacina circa 11 mm. longa tubulo 2.5 mm. sparsis longis pilis munita, lamina 1.5 mm. lata apice 3-dentata, ramis stylaris linearibus glabris circa 2 mm. longis, ovario 1.8 mm. longo villoso et sparse glanduloso. Pappus rubellus 5–6 mm. longus pilis hispidulis subapice vix ampliatis exterioribus brevioribus. Flores disci hermaphroditi tubulosi circa 10, corolla 6 mm. longa sparse puberula, tubulo 2–2.2 mm. longo praecipue apice longis pilis munito, dentibus oblongis 1.5 mm. longis apice pilis crassis brevibus munitis, antheris breviter sagittatis 2.2 mm. longis, ramis styli semiteretibus linearibus 1.5 mm. longis extus dense hispido-papillosis, ovario pappoque exteriores similibus. Receptaculum alveolatum 2 mm. diam. marginibus alveolorum crassiuscule dentatis.

TYPUS: Ecuador, Loja: Horta-Naque 3500–3800 m. alt. "Arbusto erguido, denso follaje. Hojas 7 × 4 mm. coriáceas lanosas envés. Flores color lila claro. "colect. 9-II-1946 Reinaldo Espinosa E-979. (F).

Other specimens: Ecuador: prov. Pichincha 3400–3500 m., Sec. Oriental de las Hedas. Pedregal y Yanurcu en Chaparro de Sedritana. "Arbusto achaparrado. Cabezuelas lilas." Colect. 7-VII-1944 M. A. Acosta Solís 8310 (F). Ecuador, Loja, Horta-Naque 3700–3800 m. "Arbustito. Hojas brillantes haz, lanosas envés, bordes revueltos, cordiformes 5 × 4 mm. Flores exteriores lilas," colect. 9-II-1946 Reinaldo Espinosa E-1016. (F).

D. espinosae is related to *D. lavandulifolium* and *D. hartwegii* Hier. and differs by the elliptical form of the leaf blades which appear articulate with the petiole; it is almost flat with only a very small revolute margin. The crispate, lanate, rather lax indument of the branchlets is another characteristic feature.

Diplostephium fosbergii Cuatr., sp. nov. Frutex 3 met. altus ramis griseis terminalibus squamuloso-puberulis deinde glabratis.

Folia alterna integra tenuiter coriacea. Petiolus 6–8 mm. longus supra sulcatus basi paulo incrassato-vaginatus. Lamina elliptico-lanceolata basi cuneata apice obtusa mucronulata margine dentato-serrata dentibus mucronulatis 1–1.5 mm. altus 2–10 mm. inter se distantibus, 4–8 cm. longa, 1.5–2.5 cm. lata; supra viridis glabra nervo medio conspicuo nervis secundariis reticuloque laxo pallidis notatis; subtus viridi-ochracea indumento squamuloso-pulverulento valde adpresso obtecta costa crassa eminenti brunnea glabrata nervis secundariis 8–10 utroque latere ascendentibus prominulis marginem versus furcatis et evanescentibus, reliquis venulis obsoletis.

Inflorescentiae paniculatae corymbiformes terminales folia paulo excedentes circa 8 cm. longae et latae, ramulis ascendentibus pilis squamosis adpressis vel patentibus munitis. Capitula radiata breviter pedicellata in glomerulos per 3–7 ad terminationes ramulorum disposita, pedicellis 2–5 mm. longis. Involucrum cylindraceum 8 mm. longum circa 4 seriatum bracteis ovatis et lanceolatatis acutis, extus paulo araneosis, interioribus anguste linearibus 6 mm. longis 0.7–1 mm. latis. Receptaculum 1.6 mm. latum alveolatum margine alveolorum dentato. Flores radii feminei ligulati circa 14, corolla glabra 6.5–7 mm. longa tubulo 3.5–3.8 mm. longo lamina 0.5–0.8 mm. lata. Flores disci hermaphroditi tubulosi circa 18, corolla 5 mm. longa glabra tubulo 2 mm. longo dentibus 1.2 mm. longus; antheris 2 mm. longis basi obtusis; ramis stigmaticis linearibus 1.2 mm. longis hispido-papillosis. Ovarium 2–2.2 mm. longum sparse glandulosum. Pappus 4.5 mm. longus fulvus pilis hispidulis apice leviter ampliatis, exterioribus brevibus. TYPUS: Colombia: Cord. Oriental, Int. del Meta: Rio Arroz well above confluence of Quebrada Pedregal 3445 m. alt. Brushy bank of stream, edge of cultivated patch. Shrub 3 m. tall, heads greenish brown. Collect. 29 Aug. 1943, F. R. Fosberg 20912 (F).

D. fosbergii is close to *D. denticulatum* Blake, but from this and other related species it is distinguished by the special scaly pulverulent, very much compressed indument at the underside of the leaves, only the secondary veins being conspicuous; the upper side has a pale reticulation. This species also is characterized by somewhat lanceolate-obtuse, dentate leaves, by the intricate or adpressed, squamose-like hairs of the branchlets of the inflorescence, by short pedicels, and by the scattered glands on the fruits.

Diplostephium grantii Cuatr., sp. nov. Frutex 2.5 met. altus ramis terminalibus angulatis adpresse arachnoideo-tomentosis fulvis.

Folia alterna simplicia rigide coriacea lata. Petiolus 1–4 cm. longus robustus striatus dense tomentosus, supra sulcatus basi breviter vaginatus. Lamina oblongo-elliptica ad 14–16 cm. longa 5.5–6 cm. lata, (in extremis ramulorum minor 7–3.5 cm. longa 2–1 cm. lata) basi cuneata apice rotundata vel obtusissima, margine integra revoluta; supra viridis in juvenilibus nervis principalibus crispo-pilosis denique glabratis, costa valde impresso-conspicua nervis lateralibus perpendicularibus parallelis 25–28 utroque latere (in foliis maximis) impressis bene conspicuis prope marginem furcatis nervulis transversis laxe reticulatis minus conspicuis; subtus dense

adpresseque fulvo-tomentosa costa crassissima eminentissima striata nervis secundariis prominentibus nervulis tertiis prominulis laxissime reticulatis.

Inflorescentiae terminalis corymboso-paniculatae basi foliosae folia superiora suberecta aequilongae ad circam 14 cm. altae dense floribundae; ramis ramulisque subfastigiatis dense lanuginoso-tomentosis fulvis. Capitula parva radiata ad extremos ramulorum 5–14 mm. longos rigidos solitaria vel 2–7 subsessilia vel sessilia glomerata. Involucrum campanulatum 6 mm. altum 4 mm. latum bracteis 4–5 seriatis paleaceis stramineis ochraceo-lanuginosis, ovatis acutiusculis margine scariosis, interioribus anguste linearibus 4–5 mm. longis 1 mm. latis. Receptaculum 1.6 mm. diam. alveolatum marginibus alveolorum membranaceis paleaceo-dentatis, ad 1 mm. altis. Flores marginales feminei circa 10 ligulati, corolla alba anguste lineari 5.5–6 mm. longi glabra tubulo 3 mm. longo lamina 1 mm. lata. Flores disci hermaphroditi tubulosi circa 15, corolla 5 mm. longa parte media sparse puberula tubulo 2 mm. longo limbo profundo 5-dentato dentibus oblongis 2 mm. longis; antheris 2 mm. longis basi breviter sagittatis; ramis stigmaticis linearibus papilloso-hispidulis circa 0.8 mm. longis. Ovaria radii ovato-oblonga costata parce hispidula circa 2 mm. longa pappo 4.5 mm. longo albicanti pilis sericeis tenuibus exterioribus brevibus. Ovaria disci linearia longiora magis hispida pappo pilis apicem versus ampliatius.

TYPUS: Colombia, Dep. Magdalena, Sierra de Perijá, 10 km. east-ne of Manaure, 46 km. east of Valledupar. Páramo 2550 m. alt. Shrub 8 feet, leaves tawny-tomentose below. Rays white. Collect. Feb. 4, 1945 Martin L. Grant 10791. (F).

D. grantii belongs to the group of *D. ellipticum* Cuatr. and *D. denticulatum* Blake, but is strikingly different for its large, elliptical, coriaceous and firm leaves which have close, strongly marked transversal nerves beneath, and for the more adpressed woolly tomentum on the branchlets and underside of the leaves; the lower leaves exhibit the largest size in the genus. Besides this, the small sessile glomerulate heads (or some isolated, pedunculate), and the strongly striate branchlets, petioles, medium nerves also characterize the species.

Diplostephium goodspeedii Cuatr., sp. nov. Frutex 2 m. alta congeste ramosus ramis griseis ramulis hornotinis cinereo-lanatis denique glabrescentibus.

Folia alterna coriacea. Petiolus circa 3 cm. longus basi incrassatus et dilatato-vaginatus. Lamina lanceolato-linearis apice acuta basi in petiolum attenuata margine integra revoluta, 1.5–3 cm. longa 3–5.5 mm. lata; supra valde juvenilis parce araneoso-lanuginosa, mox glabra, opaca leviter rugosa, costa depressa reliquis nervis obsoletis; subtus crasse denseque lanata albida vel subargentea tantum costa paulo velata conspicua.

Capitula radiata terminalia solitaria. Pedicelli crassi dense lanuginosi 6–10 mm. longi quam folia breviores. Involucrum subcampanulatum bracteis 4–5 seriatis, interioribus anguste linearibus acutis 10–11 mm. longis margine parce lacerato-ciliatis, mediis exterioribusque oblongis et oblongo-ovatis acutis nervo medio elevato lanuginosis, minimis circa 3 mm. longis 2 mm. latis. Flores exteriores feminei numerosi, corolla 18 mm. longa glabra

tubulo angusto 4 mm. longo lamina 2 mm. lata, ovario paulo pubescenti. Flores disci hermaphroditi numerosi, corolla glabra circa 7 mm. longa tubulo 2 mm., antheris 2.5 mm. longis basi acutis, ramis stigmaticis linearibus elongatis papillosis, ovario paulo pubescenti. Pappus brunneo-stramineus.

TYPUS: Peru, Dep. Cuzco, Prov. Urubamba: near Wenner Gren ruins; alt. 3400–3600 m. Shrub 2 m. high; involucre greenish brown; ray flowers light purple. Wet sphagnum hillside in open, much fog and rain. Collected by R. D. Metcalf (n. 30747) as a member of the University of California Expedition to the Andes directed by Prof. Thomas Harper Goodspeed.

D. goodspeedii is close to *D. haenkei* (DC.) Wedd., from which it differs by its narrower, linear, thicker and firmer leaves which have a thicker and whiter tomentum on the lower side; the heads are solitary or apparently in groups of two terminating short, adjacent branchlets. This plant clearly appears to me to be a species different from *D. haenkei* in spite of intermediary forms found in the region of Cuzco (f. i. Vargas 1297) which may have an hybrid origin.

Diplostephium gynoxyoides Cuatr., sp. nov. Suffrutex 1.60 met. alta ramulis plus minusve flexuosis crasse denseque lanato-tomentosis ochraceis.

Folia alterna simplicia coriacea patentia vel reflexa. Petiolus circa 2 mm. longus vaginatus arcuatus dense albo-lanatus. Lamina crassa rigida elliptica vel ovata basi rotundata apice rotundata vel obtusa margine revoluta grosse dentata vel subintegra, 10–17 mm. longa, 7–10 mm. lata; supra viridis subnitida paulo rugosa costa impressa ceteris nervis plus minusve conspicuis depressisque pilis copiosis minutissimis acutis praedita; subtus dense crasseque tomentoso-lanata ochracea sed nervo medio albicanti notato.

Capitula radiata apicalia in ramusculis terminalibus brevium foliatis, foliis superioribus minoribus subbracteiformibus. Involucrum hemisphaericum 8–10 mm. altum bracteis copiosis imbricatis, exterioribus medianisque ovalibus acutiusculis subochraceis arachnoideo-lanatis, interioribus anguste linearibus acutis, 8.5 mm. longis, 1 mm. latis glabriusculis, omnibus margine lacerato ciliatis. Receptaculum profunde alveolatum margine alveolorum crasse membranaceum dentatum dentibus ad 0.8 mm. altis. Flores radii feminei ligulati numerosi, corolla azurea lineari oblonga 22 mm. longa 1.5 mm. lata tubulo brevissimo 0.6 mm. longo; stylo 3 mm. longo ramulis linearibus 1.5 mm. longis minutissime papillosulis. Flores centrales hermaphroditi tubulosi, corolla lutea 5–5.5 mm. longa parce pilosa tubulo 1 mm. longo dentibus linearibus 1 mm. longus glabris; antheris 2 mm. longis basi breviter sagittatis, ramis stigmaticis linearibus 1.5 mm. longis papillosi hirtulis. Ovaria hispidula 1.8 mm. longa. Pappus ochraceo-rubellus 5–6 mm. longus pilis teneribus hispidulis exterioribus brevibus.

TYPUS: Peru: Dep. Huanuco: Pillao 2700 m. alt. in low shrubbery reaches the altitude of nearly 4000 m. Flower blue with dull yellow center. Leaves very dark green, underneath beige, stem beige. Collect. 14-II-1946 Felix Woytkowski 34049 (F).

D. gynoxyoides is close to *D. haenkei* (DC.) Wdd., from which it differs by the short elliptical or ovate leaf blade abruptly separate from the petiole.

It also differs by the marked nerves on the minutely pubescent upperside of the leaves giving them a rugose aspect, and by the more floccose tomentum on the branchlets and leaves beneath. In some way these plants look like some fruticose Andean *Senecio* and *Gynoxys*.

Diplostephium lacunosum Cuatr. Frutex 2–3 met. altus ramis terminalibus crasse denseque lanato-tomentosis.

Folio alterna integerrima crasse coriacea, sesillia. Lamina anguste oblonga linearia margine valde crasseque revoluta apice obtusa basi gibbosoincrassata 8–18 mm. longa 1.5–2.5 mm. lata; supra pallido-viridis dense et minutissime granulato-glandulosa; subtus crasse denseque lanato-tomentosa cinerascens.

Capitula radiata mediocria solitaria vel pauca subsessilia ad terminationem ramulorum. Involucrum 8 mm. longum bracteis crasse paleaceis circa 4 seriatus anguste ovatis vel oblongis obtusiusculis parce arachnoideis copiose granulato-glandulosis, interioribus linearibus 7 mm. longis 1–1.5 mm. latis. Receptaculum circa 2 mm. alveolatum marginibus alveolorum dentatis. Flores radii feminei ligulati, corolla circa 14 mm. longa tubulo sparse hispidula 4.3 mm. longo lamina 1.5 mm. lata. Flores disci hermaphroditi tubulosi, corolla hispidula 7 mm. longa tubulo circa 2 mm. limbo tubuloso vix dilatato dentibus 1 mm. longis extus apice glandulosis ramis stigmaticis oblongis hispidulis 0.6 mm. longis. Ovarium sparse glandulosum pilosum vel glabratum.

TYPUS: Colombia, Boyacá: Nevado del Cocuy, alto valle de Las Lagunillas páramo 4000–4300 m. alt., coleet. 12 Sept. 1938 J. Cuatrecasas 1443. (F).

D. lacunosum is classified in the Sec. *Bifidum* Cuatr. and can be distinguished by its thick, coriaceous, linear, revolute leaves, about 11–15 mm. long and 2–2.5 mm. broad, which are covered with minute granulose glands above and have a woolly tomentum beneath. The heads are somewhat incomplete in the specimens at hand (perhaps damaged by insects) and do not permit a more adequate description.

Diplostephium peruvianum Cuatr., sp. nov. Frutex ramulis erectis brunneis hirsutis, pilis crassis vermiformibus acutis patentibus copiosis obtectis.

Folia parva alterna integra, petiolo 1–2 mm. longo basi vaginanti, apice cum limbo subarticulato, ad ramum plusminusve adpresso puberulo. Lamina tenue coriacea patens obovato-elliptica basi obtusa vel rotundata apice abrupte angulata subacuta margine integerrima anguste revoluta, supra glabra viridis nitida costa prominula, subtus dense adpresseque tomentoso-lanata cinerea nervo medio vix vel haud notato, 6–10 mm. longa, 3–5 mm. lata.

Capitula radiata solitaria terminalia mediocria. Involucrum 10 mm. longum bracteis 6 seriatis anguste ovato-oblongis, exterioribus crasse paleaceis mucronulatis mediis lanceolatis parce puberulo-arachnoideis margine ciliatis, interioribus angustioribus circa 9 mm. longis 1 mm. latis scariosis subglabris apicem margine ciliatis. Flores radii feminei ligulati circa 21, corolla pallido-purpurea 14 mm. longa tubulo 1.6 mm. longo lamina lineari 1.5 mm. lata apice breviter 3 dentata, ramis stylaris 1.5 mm. longis tenuibus glabris. Flores disci hermaphroditi circa 28, corolla puberula 6.5 mm. longa

tubulo 1.2 mm. longo dentibus 1 mm. longis, antheris basi breviter sagittatis ramis stigmaticis lineari-subulatis hirtulo-papillosis, 1.5 mm. longis. Ovaria 1.5 mm. longa hirtula et glandulosa. Pappus 6.5 mm. longus pilis hispidulis teneribus, exterioribus brevioribus (1 mm. longis).

TYPUS: Peru, Dep. Huanuco: Seriapampa, 3600 m. alt., open spaces dwarf wood, reaches puna (4000 m.). Flower purple center brown. Leaves gray underneath. Stem brown. Collect. 5-V-1946 Félix Woytkowski 34285. (F).

D. peruvianum is close to *D. vermiculatum* Cuatr. and *D. hippophae* Blake by having the same kind of thick vermiculoid hairs on the branchlets. From both it differs by its shorter, elliptical, abruptly petiolate leaves. *D. hippophae* (the type specimen in F. having lost its flowers) has been described as monocephalus, and it is a plant of rosmarinoideous aspect with linear leaves pale beneath. *D. vermiculatum* is very close to the last one but it differs by the heads gathered in a small corymb and by its likewise linear but broader leaves.

Diplostephium ramiglabrum Cuatr., sp. nov. Frutex ramulis terminalibus viridibus angulatis glaberrimis.

Folia parva alterna integra crassiuscule coriacea petiolo brevi (circa 2 mm. longo) basi incrassato-gibboso et ampliato vaginanti. Lamina elliptico-oblonga vel obovato-oblonga basi attenuata apice acuta margine integra crasse revoluta 6–10 mm. longa 3–5 mm. lata; supra viridis laevis glabra nitida tantum nervo medio angusto depressoque interdum visibili; subtus dense crasseque subochraceo-crispo-lanato-tomentosa costa crassa prominenti.

Capitula radiata latiuscula solitaria terminalia breviter pedunculata. Involucrum 10 mm. altum late campanulatum bracteis 6-seriatis membranaceo-paleaceis oblongis, exterioribus ovatis acutiusculis 4 mm. longis 2 mm. latis, interioribus late linearibus 9 mm. longis 2 mm. latis acutiusculis, omnibus parcissimi tomento arachnoideo deciduo mox glabris margine valde lacerato-ciliatis. Receptaculum 3.5 mm. diam., alveolatum marginibus alveolorum crassiusculis dentatis. Flores radii feminei ligulati circa 20, corolla lineari 14 mm. longa 1.5 mm. lata tubulo 2 mm. longo subglabro, ramis stigmaticis glabris 1 mm. longis. Flores disci hermaphroditi numerosi corolla lutea 6 mm. longa parte media breviter pilosiuscula tubulo 3 mm. longo dentibus ovato-linearibus 1 mm. longis; antheris 2 mm. longis breviter sagittatis; ramis stigmaticis lineato-subulatsi acutis hirtulo-papillosis 1.5 mm. longis. Ovarium 2 mm. longum dense hispidum. Pappus 5 mm. longus setis hispidulis ochraceis apice vix ampliatis exterioribus brevioribus (0.5–1 mm. longis).

TYPUS: Ecuador: Loja: Horta-Naque 3700–3800 m. alt. "Arbusto duro. Hojas brillantes en el haz, lanosas en el envés. Bordes revolutos 11 × 5 cm. Cabezuelas solitarias al extremo de las ramas. Flores inferiores amarillas." Colect. 9-II-1946 Reinaldo Espinosa E-1002. (F).

D. ramiglabrum belongs to the Sec. *Bifidum* Cuatr, and Series *Lavandulifolia* Blake and is well characterized by its glabrous branchlets, its thick

coriaceous, elliptical, small, leaves which are nitid above and woolly beneath, by the gibbous base of the petiole and its broad, scarious-strawy bracts.

DIPLOSTEPHIUM GLUTINOSOM Blake, fma. **mycrophyllum** Cuatr., nova.

Frutex nanus, foliis 3–9 mm. longis, 1.5–2.5 mm. latis.

TYPUS: Colombia, Santander: Páramo de Santurbán near Vetas, 3950–4160 m. alt. "Shrubby herb. Rays white. Florets deep pink." Coll. Killip & A. C. Smith 17487. (US).—Alto del Almorzadero, 3965 m. alt. Open paramo on divide. "Shrub, fl. white", coll. H. St. John 20799 (F).

DIPLOSTEPHIUM PLEISTOGYNUM Blake var. **orientale** Cuatr., var. nov.

Differt: folia acute longiuscule mucronata, ovaria dense hispida et glandulosa, pappus salmoneus.

Typus: Venezuela, Táchira: Páramo de Tamá, 3100–3300 m. alt., collect. July 1939, Félix Cardona 316 (US).

The typical forms of *D. pleistogynum* have glandular, scarcely hairy ovaries and apiculate leaves, but in the Cordona plant the leaves end in an actual little spine, and the achaenia, besides being glandular, are densely hispid.

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HYDROLYSIS OF SUCROSE BY AUTOCLAVING MEDIA, A NEGLECTED ASPECT IN THE TECHNIQUE OF CULTURE OF PLANT TISSUES.[1]

ERNEST BALL[2]

In studying the utilization and transformation of sugars during the growth of the callus of *Sequoia sempervirens* upon basal medium (Knop's solution according to Nobécourt 1937 and Gautheret 1942), it was necessary to be sure that sterilization did not alter the sugar. Preliminary tests were carried out by sterilizing the basal 3% sucrose medium by autoclaving, on the one hand, and by filtration of the sugar solution through ultrafine, fritted glass bacteriological filters on the other. In the latter case, the sterile sugar solution plus the 1 mg. per liter of indoleacetic acid were added without contaminataion to the autoclaved agar-water-mineral portion of the medium after it had cooled almost to room temperature. After sterilization, the media were extracted with 80% ethanol, and the sugars were separated and identified by paper-partition chromatography. The medium with sugar sterilized by filtration contained only sucrose, while the medium sterilized by autoclaving contained sucrose plus a smaller proportion of glucose and levulose (fig. 1). Obviously, some of the sucrose had been hydrolyzed to its constituent hexoses. Calculations, utilizing the findings of Fisher, Parsons and Morrison (1948) that the length or area of a spot on a chromatogram is proportional to the logarithm of its concentration, indicated that there was from 0.7% to 0.9% glucose or levulose present after autoclaving the original 3% sucrose medium. Burström (1941) reported that sucrose is not stable when autoclaved at 110° C. with weakly acid mineral solution, and that part of it is split into glucose and fructose. So far as the present writer is aware, Burström's results have not been considered in any recent studies except those of Street and Lowe (1950) who assumed that no hydrolysis of sucrose occurred on autoclaving White's solution. They based their conclusion solely upon the obtaining the same growth patterns in tomato roots cultured on autoclaved vs. non-autoclaved sucrose. They made no chemical tests or chromatograms of the sugars in the autoclaved sucrose medium.

Callus cultures of *Sequoia* grown on these two differently sterilized media had quite different growth patterns. Those grown upon the heat-sterilized sucrose (mixture of sucrose, glucose and levulose) were rough in texture, brownish-green in color, and attained a large size (fig. 2) in the course of

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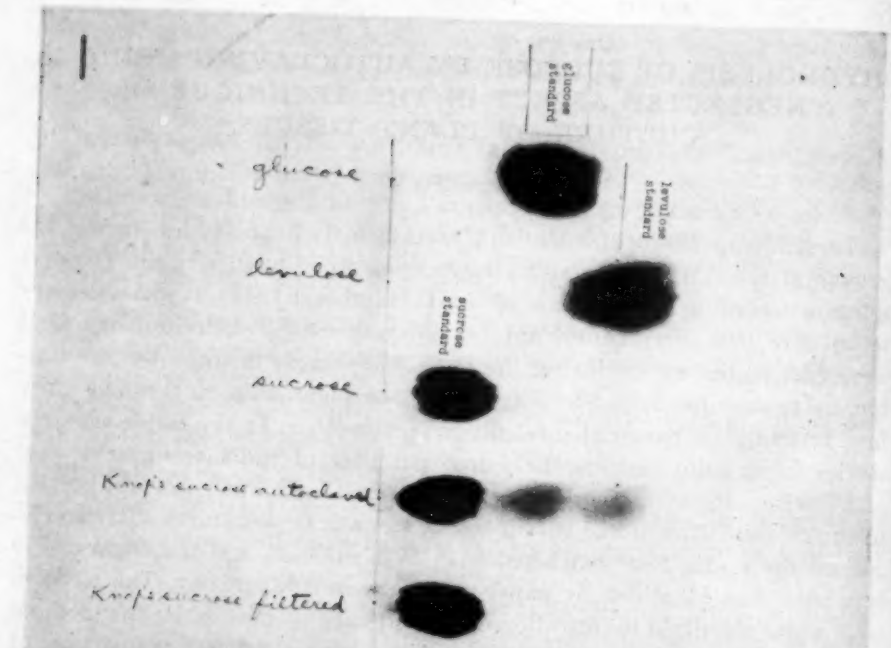
1
glucose standard
levulose standard
sucrose standard
glucose
levulose
sucrose
Knop's sucrose autoclaved
Knop's sucrose filtered

2

3

two months. Those grown upon filtered sucrose were smooth in texture, pale green in color, and usually attained a much smaller size (fig. 3) than those on the other medium.

Since the autoclaving at the standard time of 15 minutes and 15 pounds pressure resulted in the hydrolysis of the sucrose in the presence of the basal medium (Knop's solution and indoleacetic acid, pH 5.5), it was thought possible that a similar effect might be found in other media used for the culture of vascular plant tissues. Accordingly, White's medium (White, 1943) containing sucrose and Knudson's B medium (Knudson, 1922) also containing sucrose (originated for germination of orchid seeds and growth of the seedlings) were autoclaved under the same conditions. Paper chromatograms of the 80% ethanol extracts of these two media showed that the sucrose of White's medium underwent a smaller amount of hydrolysis than did that of Knudson's, but both showed prominent spots on the paper for glucose and levulose. It has been shown by a number of investigators that all three of the media, containing autoclaved sucrose, support excellent growth of a wide variety of tissues. They should, however, no longer be designated as containing solely sucrose.

The different growth pattern of calli of *Sequoia sempervirens* on autoclaved sucrose (containing sucrose, glucose and levulose) from that on filtered sucrose (containing only sucrose) suggests fundamental differences in the utilization of sugar by this tissue.

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Fig. 1. Chromatogram of standard sugar solutions and of Knop's culture medium with filtered-sterilized sucrose and of Knop's culture medium that had been autoclaved after addition of sucrose. The autoclaved sucrose medium shows, by the distinct spots for glucose and for levulose that hydrolysis of some of its sucrose had occurred. The culture medium to which filtered-sterilized sucrose had been added contained only sucrose. Magnification × ½. Fig. 2. Callus grown two months upon Knop's medium containing heat-sterilized sucrose. The culture was large, the color brownish green, and the texture was rough. Magnification × 1. Fig. 3. Callus grown two months upon Knop's medium containing filtered-sterilized sucrose. The culture was much smaller than the former, the color was light green, and the texture was smooth. Magnification × 1.

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STROPHANTHUS GLABRIFLORUS MONACH.

JOSEPH MONACHINO

In Phytologia for October, 1951, I proposed a new variety of *Strophanthus sarmentosus* P. DC. based on several French Guinea collections typified by *Pobeguin 1288*. An old fruit was then at hand in one of the specimens, but the seeds could not be examined. Subsequently, through the intermediation of Professor T. Reichstein, Basel, Switzerland, complete botanical material of the same taxon, collected by A. Pitot, was sent to me for study.

As in the material examined previously, the leaves in the Pitot specimens are opposite, coriaceous, narrowed at base, the reticulation of veinlets obscure or faint on underside, not conspicuous as is usual in *S. sarmentosus*. The floral characters originally described—flowers few on leafy stems, corolla externally glabrous, small glabrous sepals—hold in Pitot's collections. The structure of the corolla and its internal organs, and the indumentum within, are as in *S. sarmentosus*. The flowers are large (corolla-tube 2–4 cm. long) and the ovary is glabrous. The narrow follicle has a slender tapering neck, relatively thin wall with surface faintly lenticelled. Perhaps the fruit somewhat recalls the Senegal variety of *S. sarmentosus*, but the seeds are very different from any variety or form of the species. The hairs on the seed are long, up to 0.6 or 0.9 mm.; the naked part of the awn is very short, less than 1 cm. (mostly 3–4 mm.), so that the plume appears almost sessile. The plant is thus distinguishable in flower and in fruit, and I propose elevation of the variety to specific rank:

Strophanthus glabriflorus (Monach.) Monachino, comb. nov.
S. sarmentosus var. *glabriflorus* Monach., Phytologia 3 (9): 479. 1951.

The flowering and fruiting specimens collected by A. Pitot (*762* & *763*, Route de Télimélé vers Kindia dont de la Kaffima, tournée 1951; *s.n.*, loc. cit., received 13 October 1950) were called "Strophanthus de Télimélé." The previous collections were by H. Pobeguin in the vicinity of Kindia (*28*, Friguiagbé à Bambaya, September 1899; *95*, Kouroussa, gare de la Lanfofomé, March 1904; *1288*, commun près de Kindia, en bord de la ona-ona, 1950; *s.n.*, received 29 October 1900), and Maclaud (oh. 11.–32, limites des la Guinée française et de la Guinée portugaise, Poredaka, commun dans les haies du village, March 1902, "Kouna").

S. glabriflorus can possibly be involved only with the ascribed synonyms of the botanically closely allied *S. sarmentosus*. My reasons for judging it distinct from any of them follow:

S. laurifolius A.DC. Franchet examined a flower and leaves of the type,

"Africa (Sparmann) Herb. de Cand." He found the flower smaller than in *S. sarmentosus* (corolla-tube 15 mm. long), puberulent outside; leaves rounded or obtuse at base, the nervature like that of *S. sarmentosus*.

S. senegambiae A.DC. The collection cited was "Senegambiâ (Heudelot!) . . . (v. in h. Boiss.)." I have examined *Heudelot 337* from Senegal, named *S. senegambiae* at Geneva. The species is best conceived as the sarmentogeniferous variety of *S. sarmentosus* (forma *senegambiae* chevalier), which ranges in the northern border of the species, from Senegal to northern Nigeria, mostly in savanna or arid areas. This seems the most practical disposition, although fruits are lacking in the type, and the variety is distinguished chiefly by fruit character and seed chemistry.

S. ogovensis Franchet. I have seen the syntypes.

S. paroissei Franchet. Based on a mixture, the fruit of probably typical *S. sarmentosus* (seeds with long naked awns over 3 cm., and short hairs 0.3–0.4 mm.) and leaves of *Alafia*.

S. punctiferus Chevalier. Although the type was not available, a fresh collection from the type plant (or the type locality) was received from the original collector.

S. pendulus Kummer & Hooker. With the exception of the illegitimate *S. paroissei*, none of the above species compared with *S. glabriflorus* was collected in French Guinea. On the other hand, the type of *S. pendulus* was obtained in the same territory: "hab. Santo Fallo . . . collected by Cherif Side Mohommed of Foota Jallo." This type was probably lost. The description and illustration can hardly serve to distinguish *S. pendulus* from *S. sarmentosus*, in the synonomy of which it was placed by Gilg, Stapf, and others. No indication is given regarding the indumentum on the corolla and ovary, or of size and indumentum of the sepals ("laciniis ovatolanceolatis, acutis" better suggest typical *S. sarmentosus*, the sepals of *S. glabriflorus* being mostly oblong or ovate-lanceolate-oblong, not notedly acute). The special character observed in the original description, anthers adhering by their base within and being firmly attached to the stigma, is true of all species of *Strophanthus* with mature flowers. Typical *S. sarmentosus* has been frequently collected in French Guinea, even in the localities cited for *S. glabriflorus*, between Kindia and Télimélé and in the environs of Kouroussa.

The published varieties and forms of *S. sarmentosus* were based on the species reviewed above, except for *S. sarmentosus* var. *major* Dewèvre, a Belgian Congo variety with broad thickly-lenticelled follicles, and *S. sarmentosus* var. *pubescens* Staner & Michotte, based on flowers of *S. sarmentosus* var. *major* and leaves of a *Motandra*. *S. sarmentosus* var. *verrucosus* Pax is *S. petersianus* var. *grandiflorus* N. E. Brown, a plant of East Africa.

Two seeds of the Pitot collection of *S. glabriflorus* were examined by Professor H. W. Youngken, Massachusetts College of Pharmacy, who communicated: "It appears to be obvious that it is possible to distinguish the seeds of *S. glabriflorus* from those of *S. sarmentosus* by histological methods. . . . Epidermal cells of seed coat irregularly elliptical to oblong in surface view; usually up to 133 μ, occasionally up to 150 μ in length, and up to 57 μ in width, their long walls wavy, some with lumina having very irregular diameters; anticlinal walls of epidermal cells up to 21 μ in thickness. Hairs yellow, up to 950 μ in length, with obtusely pointed ends. Cotyledons, as examined in median cross sections, plano-convex, the pair of unequal length; no rosette aggregate crystals found in 8 sections studied."

The seeds of *S. glabriflorus* are under chemical investigation by Professor T. Reichstein and his co-workers. They are rather rich in glycosides different from the main products of various forms of *S. sarmentosus*. The details of their chemistry will be published in Switzerland, presumably in Helvetica Chimica Acta, where already have appeared studies of numerous species of *Strophanthus*.

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MICROSTRUCTURE OF THE WOOD OF THE THREE SPECIES OF TAXODIUM

MARGARET KAEISER

For many years there has been a conflict of opinion among plant taxonomists, dendrologists and other field workers as to the number of species of *Taxodium*. Bailey (1948), Britton (1926), Dallimore and Jackson (1948), and Rehder (1947) all recognize three distinct species, *T. distichum* (L.) Rich. (common bald-cypress), *T. ascendens* Brongn. (pond-cypress), and *T. Mucronatum* Tenore (Montezuma yew-cypress). Sargent (1933, 1947) considers the pond-cypress to be a variety of the bald-cypress and calls it *T. distichum* var. *imbricarium* Sarg. Penhallow (1907), however, lists only *T. distichum*, the bald-cypress, as the one extant species in the United States. No varietal form is mentioned.

Britton pointed out that field students have long felt that the pond-cypress is a distinct species from the bald-cypress, whereas "herbarium students" have treated it more often as a variety. Mattoon (1915) recognized at least two forms and noted that the "two forms overlap in geographical range and intergrade to such extent that it is often difficult and sometimes impossible to distinguish between them", particularly with older specimens. Both the embryogeny (Kaeiser 1949) and the pollen (Kaeiser 1939) of these two species are essentially alike, although the writer found the pollen of *T. ascendens* slightly smaller in size. According to Mattoon: "There are indications that the varietal form (var. *imbricarium*), which is more abundant over the Atlantic Coastal Plain than elsewhere, is undergoing a gradual botanical segregation during its assumed northward migration from Florida, and has been since the close of the glacial period." He regarded soil conditions responsible for the variation.

The appearance of the bark and the relative amount and color of sapwood and heartwood have been used in an attempt to separate these two forms. Thicker more furrowed bark and sapwood thinner and more uniform in width have been criteria frequently used to distinguish the pond-cypress from the bald-cypress. However, in the field many gradations have been noted.

With regard to the Mexican or Montezuma yew-cypress there has possibly been less concern about mistaken identity by workers in the United States. Its evergreen habit, its difference in time of maturation of cones, as well as other external features, have served as distinguishing characteristics. However, it should be noted that this species ranges northward into southern Texas (Britton 1926), and Dallimore and Jackson (1948) among

others call attention to the apparent existence of "intermediate forms" between *T. mucronatum* and *T. distichum*.

With these taxonomic difficulties confronting the writer, only those wood specimens assembled that were of undoubted identification were used in the analysis of the microstructure. The writer wishes to thank E. S. Harrar of Duke University, Yale University, M. Martinez of the Instituto de Biologia, Chapultepec, Mexico, and J. R. Millar of the Chicago Natural History Museum for providing samples.

Examination of the specimens listed in Table 1 all disclosed the usual

TABLE 1. *Measurements of wall thickness to give comparison of horizontal wall of ray parenchyma with tracheid walls from radial sections of early (spring) wood.*

Plant	Source	Specimen No.	Location	RAY PARENCHYMA	TRACHEID
				Horizontal wall thickness in microns (Ave. 10 counts)	Wall thickness in microns (Ave. 10 counts)
Taxodium Distichum	Chi. Nat.	73168	Missouri	2.8	2.8
" "	Hist. Mus.	21967	Mississippi	2.4	2.4
" "	"	4304	Indiana	2.9	2.9
" "	Yale	11434	—	2.6	2.6
" "	"	41285	—	2.4	2.4
" "	"	45915	Florida	2.5	2.5
" "	"	46588	Louisiana	2.5	2.5
" "	"	47160	Texas	2.7	2.7
" "	Kaeiser	K-54	Illinois	2.2	2.2
" " ("knee")	Yale	11435	—	2.7	2.7
T. ascendens	Duke	—	—	2.4	2.4
" "	Yale	40308	Florida	2.9	2.8
" "	"	492	Florida	3.0	2.9
" " (twig)	Kaeiser	—	Florida	1.7	1.7
T. mucronatum	Chi. Nat.		Mexico	1.5	3.0
" "	Hist. Mus.	—	Texas	1.6	2.9
" "	Yale	40724	Texas	1.6	3.1
" "	"	40728	Mexico	1.5	2.8
" "	"	40718	Guatemala	1.6	3.3
" "	"	35443			
" "	Inst. de Biol. Chapultepec	— —	Mexico	1.5	3.2

features of wood microstructure characteristic for the genus (Brown, Panshin and Forsaith 1949, Peirce 1936, Phillips 1941). These include: wood parenchyma abundant for conifers, with nodular cross-walls, and usually scattered in arrangement in transverse section; ray parenchyma commonly with indentures and smooth end-walls (radial section); well defined primary pit fields in the horizontal walls of the ray cells; cross-field pits 2–5, most

cupressoid, occasionally taxodioid, opposite, with aperture measurements in all three species approximately of the same range in early (spring) wood; range of height of rays likewise similar in all three species; tracheid diameter measurements also within the same range; tracheid pitting on the radial walls opposite, 2–4 in number, with crassulae common; no resin ducts; no ray tracheids. None of these characteristics serves to delimit any of the species; they are shared by all three.

Measurements of wall thickness of the horizontal walls of ray parenchyma cells with relation to the contiguous tracheid walls in early wood, however, showed the differences noted in Table 1. Phillips (1941) has reported measurements only for *T. distichum*. He reported that the horizontal walls of ray parenchyma were "thick", meaning as thick as or thicker than the contiguous tracheid wall. This agrees with the writer's findings for both *T. distichum* and *T. ascendens*. However, in *T. mucronatum* the horizontal walls of the ray parenchyma cells were consistently thinner than were the tracheid walls. (In this respect the species resembles *Sciadopitys*, the umbrella-pine of Japan, the only genus of the Taxodiaceae heretofore reported with thin horizontal walls of ray parenchyma cells. The wood of *Sciadopitys*, however, is quite unlike that of other members of this family in a number of microstructural features—absence of wood parenchyma, differences in pitting, etc.—so that its wood is easily distinguished from *T. mucronatum*.) No other significant microstructural differences among the woods were observed.

The similarity of the wood of the bald-cypress and pond-cypress strengthens the viewpoint of those workers who regard the pond-cypress as but a variant of the bald-cypress. The one distinguishing feature of the Mexican cypress could possibly be due to environmental conditions resulting in the relatively thinner walls of the ray parenchyma cells. Since the difference occurred in specimens from Texas, Mexico and Guatemala, however, the writer considers it a possible means of separating the wood of this species from the other two.

SUMMARY

1. The bald-cypress and pond-cypress cannot be distinguished from one another on the basis of microstructural features of their woods.

2. The similarity of the woods of these two forms further supports the view that the pond-cypress is a variation of the bald-cypress.

3. The wood of the Mexican or Montezuma cypress can be separated from the other two cypresses on the basis of its comparatively thinner horizontal walls of ray parenchyma cells.

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AGGREGATIONS FORMED BY MOTILE PROTOZOA

H. G. BAKER

An extremely interesting article by Robbins (1952) which has recently appeared in this journal describes the formation of regular patterns of aggregation by cultures of *Euglena gracilis* var. *bacillaris*. At the conclusion of this paper, Robbins remarks that, as far as he is aware, "a comparable phenomenon for other motile organisms has not been described."

It may be worth drawing the attention of readers to some observations made by the present writer which were published in a joint note some years ago (Jones and Baker 1946). These referred to the formation of much less spectacular (and non-geometrical) aggregations of the protozoon *Glaucoma pyriformis* when cultured in a bacteria-free 1% peptone solution. Recent discussion (Corliss 1952) suggests that this organism should be named *Tetrahymena pyriformis* (Ehrbg.) Lwoff.

Simple aggregations were formed spontaneously in some old cultures but could be produced in less than a minute by the addition to the culture (in a watch-glass) of a few drops of a solution of phenanthraquinone or a related substance of this chemical group. The aggregations appeared to start by the random meeting of a few individuals which remained in close proximity to one another although it is possible that these foci subsequently became centres of attraction to individuals outside. Those individuals adjacent to the floor of the watch-glass jostled each other but above these freely swimming, active individuals occupied another zone. The uppermost zone usually contained fewer, relatively inactive individuals.

It appeared that aggregation in this manner protected the individuals in some way from the toxic effects of the quinone for those which failed to enter an aggregation were soon killed. Explanations of the behaviour of both kinds of organisms seemingly must be based on chemotactic responses to gradients in the media produced by the organisms themselves.

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Jones, R. F. & Baker, H. G., 1946. Formation of aggregations of *Glaucoma pyriformis* Kahl by means of phenanthraquinone and other substances. Nature **157**: 554.

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NEW SPECIES AND NEW COMBINATIONS IN THE GENUS ARGYTHAMNIA

JOHN INGRAM

Through my association with Dr. Louis C. Wheeler at the University of Southern California, an interest was developed in the family Euphorbiaceae which resulted in a study of the genus *Argythamnia*. The following new species were discovered and four new combinations have been made. All taxa concerned are in the genus *Argythamnia* P. Browne subgenus *Ditaxis* (Vahl) Croizat, Journ. Arn. Arb. 26: 191. 1945.

Argythamnia Arlynniana Ingram, sp. nov. Perennis herbacea; caulibus 15–30 cm. longis, pilis strigoso-malpighiaceis; foliis sessilibus, linearis, 1–3 cm. longis, acutis, pilis strigoso-malpighiaceis; racemis ca. 5 mm. longis; floribus dioecis; floribus masculis: sepalis oblongo-linearis, ca. 3 mm. longis, acutis, extus pilis malpighiaceis, intus glabris; petalis obovatis, ca. 3 mm. longis, acutis, extus et intus glabris; glandulis ca. 1 mm. longis, obtusis, erectis; androphora ca. 2 mm. longa; staminibus 10, biseriatis; staminodiis nullis; floribus femineis: sepalis oblongo-linearis, ca. 4 mm. longis, acutis, extus pilis malpighiaceis, intus pilosis; petalis ovatis, ca. 3 mm. longis, acutis, extus pilis malpighiaceis, intus glabris; ovario subgloboso, piloso; stylis adnatis, bifidis, glabris; stigmatibus planis sed non dilatis; capsulis subglobosis, ca. 4 mm. longis, ca. 4 mm. latis; seminibus ovoideis, ca. 3 mm. longis, ca. 2.5 mm. latis, apice acutis, basi truncatis, reticulato-asperis, brunneis.

Perennial herb; stems 15–30 cm. long, freely branching from a woody base, with malpighiaceously strigose hairs; leaves sessile, linear, 1–3 cm. long, malpighiaceously strigose on both sides, apex acute, margin entire; stipules wanting; racemes not over 5 mm. long; bracts ovate, ca. 1 mm. long, glabrous on both sides, apex obtuse, margin entire; flowers dioecious; staminate flowers: sepals oblong-linear, ca. 3 mm. long, with malpighiaceous hairs outside, glabrous inside, apex acute, margin entire; petals obovate, ca. 3 mm. long, both surfaces glabrous, free from the androphore, apex acute, margin entire; glands thick, ca. 1 mm. long, wider at the top, obtuse, erect, folded toward the androphore; androphore ca. 2 mm. long; stamens 10 in two whorls of 5; staminodia wanting; rudimentary ovary present; pistillate flowers: sepals oblong-linear, ca. 4 mm. long, with malpighiaceous hairs outside, scattered simple hairs inside; petals ovate, ca. 3 mm. long, an occasional malpighiaceous hair outside along the mid-vein at the base, glabrous inside, apex acute, clawed, margin subentire; glands thin, square in radial outline; ovary hispid with simple and malpighiaceous hairs; styles united about half their length, branches bifid half their free part, glabrous; stigmas flattened but not dilated; capsules subglobose, ca. 4 mm. long, ca. 4 mm. wide, hairy; seeds ovoid, ca. 3 mm. long, ca. 2½ mm. wide at the base, apiculate, truncate at the base, reticulately ridged, brown.

TYPE: El Toro, near Morano, Coahuila, Mexico, July, 1910, *C. A. Purpus 4514* (Univ. Calif. 143272!).

This species is dedicated to my wife, Arlynn.

The following key will serve to separate *Argythamnia Arlynniana* from its closest relative, *A. lanceolata* (Benth.) Muell. Arg.:

Flowers dioecious; staminate petals free from the androphore; glands of the staminate flower rectangular in radial outline, obtuse; styles glabrous ..... *A. Arlynniana.*
Flowers usually monecious but occasionally dioecious; staminate petals united to the androphore; glands of the staminate flower deltoid in radial outline, caudate at the apex; styles hairy ..... *A. lanceolata.*

Argythamnia Gentryi Ingram, sp. nov. Perennis herbacea; caulibus 15–30 cm. longis, pilis strigoso-malpighiaceis; foliis lanceolatis, oblanceolatis, vel ellipticis, 2–2.5 cm. longis, 5–15 mm. latis, acutic vel obtusis, basi cuneatis, pilis strigoso-malpighiaceis; petiolis ca. 3 mm. longis; racemis 5–6 mm. longis; floribus monoecis; floribus masculis: sepalis lanceolatis, ca. 3 mm. longis, acuminatis, extus pilis; petalis lanceolatis, ca. 4 mm. longis, acutis, extus pilis, intus glabris; glandulis triangularis; androphora ca. 2.5 mm. longa; staminibus 10, biseriatis; staminodiis pubescentibus; floribus femineis: sepalis lanceolatis, ca. 4 mm. longis, acuminatis ad acutis, extus pilis; petalis lanceolatis, ca. 2.5 mm. longis, acutis, extus pubescentibus; glandulis rectangularis; ovario subgloboso, piloso; stylis adnatis, bifidis, pubescentibus; stigmatibus planis; capsulis subglobosis, ca. 3 mm. longis, ca. 2 mm. latis; seminibus globosis, ca. 2 mm. longis, ca. 1.75 mm. latis, apiculatis, reticulato-asperis, brunneis.

Perennial herb; stems 15–30 cm. long, with malpighiaceously strigose hairs, freely branching from a woody base; leaf-blades lanceolate, oblanceolate or elliptical, 2–2.5 cm. long, 5–15 mm. wide, with malpighiaceously strigose hairs on both sides, apex acute or obtuse, base cuneate, margin serrulate with gland-tipped teeth; petioles ca. 3 mm. long; stipules under 2 mm. long, with malpighiaceous hairs inside, pubescent outside, apex acute, margin bearing minute glands; racemes 5–6 mm. long; bracts ovate, ca. 2 mm. long, pubescent outside, glabrous inside, apex acute, margin white and bearing minute gland-tipped teeth; flowers monoecious; staminate flowers: sepals lanceolate, ca. 3 mm. long, strigose outside, pubescent inside at the tip, apex acuminate, margin white and entire; petals lanceolate, ca. 4 mm. long, united to the androphore, strigose outside, glabrous inside, apex acute, margin entire; glands triangular in radial outline, thickened at the base, free from the androphore; androphore ca. 2.5 mm. long; stamens 10 in two whorls of 5; staminodia 5, as long as the free part of the filaments, tipped with hairs; rudimentary ovary present; pistillate flowers: sepals lanceolate, ca. 4 mm. long, strigose outside, pubescent about half way toward the tip inside, apex acuminate to acute, margin white, entire but bearing minute glands; petals lanceolate, ca. 2.5 mm. long, pubescent outside, glabrous inside, apex acute, clawed, margin entire; glands rectangular in radial outline, thickened at the base, retuse or truncate at the apex; ovary pilose; styles ca. 2 mm. long, united over half their length, branches bifid half their free part, pilose; stigmas flattened; capsules subglobose, ca. 3 mm. long, ca. 2 mm. wide, hairy; seeds globose, ca. 2 mm. long, ca. 1.75 mm. wide, apiculate, reticulately ridged with stellate markings in the pits, brown.

TYPE: Cerro Tecomate, west of Pericos, Sinaloa, Mexico, February 29, 1940, *H. S. Gentry 5761* (Univ. of Calif. 651767!; ISOTYPES: Univ. Ari-

zona!; Hancock Herbarium, Hancock Foundation, Univ. So. Calif.!; Herbarium of L. C. Wheeler!). The Radio Station, Maria Madre Island, May 19, 1925, *H. L. Mason 1790* (Calif. Acad.!).

It is a pleasure to dedicate this species to Dr. Gentry.

Argythamnia manzanilloana Rose is the nearest relative of *A. Gentryi*. These species can be separated by the following key:

Stems and leaves with malpighiaceous hairs; upper whorl of stamens not exserted ..... *A. Gentryi.*

Stems and leaves with mostly simple hairs with only an occasional malpighiaceous hair; upper whorl of stamens exserted ..... *A. manzanilloana.*

Argythamnia Dressleriana Ingram, sp. nov. Perennis herbacea; caulibus 3–8 cm. longis, prostratis, pilis strigoso-malpighiaceis; foliis obovatis vel ellipticis, 1–1.5 cm. longis, 6–8 mm. latis, pilis malpighiaceis; petiolis 3–4 mm. longis; racemis ca. 5 mm. longis; floribus monoeicis; floribus masculis: sepalis lanceolatis, ca. 2 mm. longis, acutis, extus pilis strigoso-malpighiaceis, intus glabris; petalis ovatis ad elliptico-obovatis, ca. 1.5 mm. longis, acutis; glandulis linearis, erectis; androphora ca. 1 mm. longa; staminibus biseriatis; staminodiis 4 vel 5, minutis; floribus femineis: sepalis ovatis, ca. 2 mm. longis, extus strigosis, intus subglabris; petalis obovato-cuneatis, ca. 1 mm. longis, extus strigosis, intus glabris; glandulis triangularis, ca. ½ mm. longis, acutis; ovario subgloboso, piloso; stylis liberis, bifidis, pilosis; stigmatibus teretibus; capsulis ca. 2 mm. longis, ca. 3 mm. latis, pilosis; seminibus ignotis.

Perennial herb; stems 3–8 cm. long, unbranched from a woody base, prostrate, malpighiaceously strigose; leaf-blades obovate to elliptical, 1–1.5 cm. long, 6–8 mm. wide, malpighiaceously strigose on both sides, apex obtuse and occasionally retuse, base acute, margin entire with an occasional minute gland; petioles 3–4 mm. long; stipules wanting; racemes less than 5 mm. long; bracts ovate, ca. 1 mm. long, ciliate along the margin, few hairs outside, apex acute, margin entire; flowers monoecious; staminate flowers: sepals lanceolate, ca. 2 mm. long, malpighiaceously strigose outside, glabrous inside, apex acute, margin entire; petals ovate to elliptical-obovate, ca. 1.5 mm. long, with a few long strigose hairs outside at the base extending to the tip, glabrous inside, free from the androphore, apex acute, margin entire; glands linear, erect, thick, blunt; androphore ca. 1 mm. long, stout; stamens 10 in two whorls of 5; staminodia 4 or 5, punctiform; pistillate flowers: sepals ovate, ca. 2 mm. long, strigose outside, glabrous inside, apex obtuse, margin entire; glands triangular in radial outline, ca. ½ mm. long, thin, acute; ovary densely pilose with hairs that project above the styles; styles united at the base, spreading, bifid to the base, pilose; stigmas terete; capsules ca. 2 mm. long, ca. 3 mm. wide, hairy; seeds not seen.

TYPE: Vicinity of San Luis Tultitlanapa, Puebla, near Oaxaca, Mexico, August 1908, *C. A. Purpus* (Univ. Calif. 143336!).

This species is dedicated to Robert L. Dressler, my fellow student and friend.

The following key will separate *Argythamnia Dressleriana* from its nearest relative, *A. serrata* (Torr.) Muell. Arg.:

Pistillate sepals ovate; staminate petals ovate to elliptical-obovate, ca. 1 mm. long, hairy outside, but only at the base, with the hairs extending to the tip ... *A. Dressleriana.*

Pistillate sepals lanceolate; staminate petals oblanceolate, ca. 3 mm. long, hairy outside, with hairs scattered over the back, with the hairs extending beyond the tip, or shorter than the tip ..... *A. serrata.*

Argythamnia macrobotrys (Pax & K. Hoffmann) Ingram, comb. nov. *Ditaxis macrobotrys* Pax & K. Hoffmann, Pflanzenreich IV. 147(7): 425. 1914.

Argythamnia cyanophylla (Wooton & Standley) Ingram, comb. nov. *Ditaxis cyanophylla* Wooton & Standley, Bull. Torr. Bot. Club 36: 106. 1909.

Argythamnia depressa (Greenman) Ingram, comb. nov. *Argythamnia neomexicana* Muell. Arg. var. *depressa* Greenman, Proc. Am. Acad. Arts & Sci. 33: 478. 1898.

Argythamnia argothamnoides (Bertero) Ingram, comb. nov. *Croton argothamnoides* Bertero in Sprengel, Systema Vegetabilum, ed. 16, 3: 872. 1826; Steud., Nomencl. ed. 2, 1: 445. 1840. *Argythamnia Fendleri* Muell. Arg., Linnaea 34: 145. 1865; an avowedly and actually superfluous name when published, as *Croton argothamnoides* cited in synonymy was not a nomen nudum as claimed by Mueller.

I wish to thank Dr. L. C. Wheeler for technical advice and for sharing his knowledge of this genus with me.

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TORREYA

MICHAEL LEVINE. 1886–1952

Michael Levine led an unusually energetic life, weaving together the accomplishments normally expected of several individuals. He was born in Russia on April 16, 1886. After attending the village school of North Baltimore, Ohio, and public school in New York City, he received the B.S. degree from the College of the City of New York in 1906. Upon graduation from college he became a teacher, first in a public school, and, in 1912, in the public high school system of New York City. During his career Dr. Levine was in charge of the Health Department of the High School of Commerce, and at the time of his retirement in 1944 he was a member of the Biology Faculty of the High School of Science. There his enthusiasm and his unusual gifts for stimulating young students in the direction of science and research were manifest. He also gave courses in botany in the summer sessions of 1915, 1916, and 1917 in Columbia University. For most men the

arduous duties associated with the routine of teaching large classes of high school students constitute a life work. For Dr. Levine they formed merely a part of his endeavors. When his colleagues were going home in the late afternoon, he headed for his laboratory.

Dr. Levine's early scientific interests were in human and animal physiology. He started graduate work in Columbia University in 1906, with emphasis on physiology, and he wrote a number of articles in this field. However, he also began taking work in botany, and in 1913 he received the Ph.D. degree from Columbia University, under the sponsorship of Professor R. A. Harper.

His dissertation was on the cytology of the Hymenomycetes, especially the Boleti. Later he published several papers on the origin and development of lamellae in *Agaricus* and in *Coprinus*, and on the physiological properties of two species of poisonous mushrooms of the genus *Panaeolus* which appeared in commercial mushroom beds. Meantime, in 1916, he had investigated chloranthy in one of the sundews, *Drosera intermedia*, as well as some of the cytological aspects of somatic and reduction divisions in that genus.

There then followed a long series of papers on crown gall—its morphology, its occurrence and characteristics in numerous different flowering plants, and the variability of *Bacterium tumefaciens* in culture. Plant cancers were analyzed under varying conditions, including the effects of X-rays and radium emanation on their development. Animal cancers were studied cytologically, and comparisons were made with the results obtained by applying carcinogenic agents to plants. Through this work Dr. Levine became recognized as a world authority on plant cancers.

As often happens, this somewhat specialized research led to the consideration of fundamental botanical problems of wide import. In 1947–1950 Dr. Levine studied differentiation of carrot root tissue grown in vitro. The culture of carrot tap-root meristem, and of stem segments of sunflower and tobacco, was carried on, preparatory to analyzing the effect of growth substances and chemical carcinogens on carrot root tissue. Plant tissue was also treated with colchicine and acenaphthene in combination with X-rays. Dr. Levine published some sixty-odd scientific articles, and they were all solid contributions.

Until 1916 this work was done in the laboratories of Columbia University. During the first World War he did plant disease work in the Middle West. From 1916 to 1924 Dr. Levine was biologist at Montefiore Hospital, and from 1924 on he was biologist in charge of the cancer research laboratory. From 1944–1946 he served as assistant director of Montefiore Hospital. Almost to his death, on August 26, 1952, he worked daily in his laboratory at the Hospital.

Dr. Levine was elected to membership in the Torrey Botanical Club on October 13, 1908, and to life membership on October 5, 1948. He was associate editor from 1918 through 1947, and business manager from 1927 through 1943, although he apparently started doing the work of the business manager in 1920. He served on the Council for many years, and led numerous field trips, especially for the study of mushrooms and other fungi. He was president of the Torrey Botanical Club in 1944. He was awarded the alumni medal for conspicuous Columbia alumni service in 1933, and was elected president of the Alumni Association of the Graduate Schools of Columbia University in 1935.

He is survived by his wife, a married daughter, and a grandson.

Dr. Levine was a buoyant, sympathetic, innately modest man. With all of his activity he was never in a hurry, and he was always friendly and gracious. He gave unsparingly of himself, and was ever ready and cheerfully willing not merely to help, but to do more than his share. In the world of academicians, in which he largely moved, his counsel was continually sought, for he had great common sense, a stalwart heart, and a large, warm hand.—Edwin B. Matzke, Columbia University.

Field Trip Reports

April 4, 1953. Sergeantsville, N. J. to Oxford, N. J. The group managed to relocate what was probably the old stand of table mountain pine (*Pinus pungens*), but not without some search. Apparently the grove is much reduced in size. Some of the large, distinc-

tive cones were collected. Some extremely showy spring beauties were observed near the covered bridge at Sergeantsville. In the sunlit glens nearby bloodroot and Dutchman's breeches abounded. Asbestos was collected at Oxford, while after dusk specimens of the swamp cricket from (*Pseudacris nigrita feriorum*) were obtained near Locktown. Attendance: 9. Leader, Forrest P. Dexter, Jr.

April 11. Rancocas Creek, N. J. A pleasant cruise, some five miles upstream and return, resulted in several worthwhile observations. Quite a few red-bellied terrapins were noted at several points along the stream. They are sly and difficult to catch, but we managed to get within five feet of one. "Flower of the day" was most likely the ominpresent fawn lily. We kept a lookout for climbing fern and fringe tree, but saw none of either, the season probably not sufficiently advanced. Several kingfisher cavities were seen in the deep bluffs along the riverbank. Songs of the Carolina wren emanated from the thickets along the shore. Attendance: 9. Leader, David Fables.

April 12. Queens County, New York. Horned larks, piping plovers, savannah, sharp-tailed, swamp and song sparrows, great blue herons, a greater yellow legs, marsh hawks and Canada geese were seen in the Jamaica Bay area. Several ruby-crowned kinglets, in the Queens Botanical Gardens, obligingly displayed their colorful crowns. The high point of the day was an excellent view of two clapper rails. Attendance: 4. Leaders, Harriet J. Brown and Marion R. Sonner.

April 22. Appalachian Trail Maintenance Work. The signs were in no need of repainting, so we removed a little brush from the Trail and retired to the lowlands to botanize. Large bloodroot plants were photographed near Swartswood Lake. Hepatica, violets of many species, early saxifrage, cut-leaved toothwort and golden ragwort were in bloom everywhere. Attendance: 3. Leader, David Fables.

April 25. Frenchtown, N. J. We searched for squirrel corn, but to no avail. In fact we failed to find Dutchman's breeches in the region covered (two–three miles north of Byram). Yellow corydalis was seen at several points. The region in general seems much less productive botanically than the corresponding territory on the Pennsylvania side of the Delaware River. Attendance: 5. Leader, David Fables.

April 25. Malaga Lake, N. J. Joint trip with the Botanical Society of Pennsylvania. No rarities were reported but fine colonies of the bird-foot violet (*V. pedata* var. *linariloba*), swamp pink (*Helonias bullata*), and golden club (*Orontium aquaticum*) were admired in full anthesis. The great white cedars of Parvin State Park were measured, some being over seven feet in circumference (86¾ inches). A new station for mistletoe (*Phoradendron flavescens*) was discovered. Attendance: 15. Leader, Louis E. Hand.

May 3. Trailside Museum, Watchung Reservation, Union County, N. J. The Club participated in the opening of Trailside Museum's twelfth season. Approximately 2500 persons attended but Torreyites were not segregated in the count. There were early morning birds walks sponsored by the Summit and Watchung Nature Clubs and Westfield Bird Club, followed by a field trip to study plant life led by the Director, Dr. H. N. Moldenke. About 55 persons were on this walk and some 250 species of plants were identified. In the afternoon the new wing to the Museum was dedicated with talks by Commissioner Ralph P. White of the Union County Park Commission, Dr. Moldenke, Mr. Elwood Furth, Mrs. Mildred Rulison, and Mr. Frank McLaughlin of the N. J. Audubon Society. In the evening the spring series of lectures on star lore, conducted by Mr. Norman Spatz, was initiated.

May 3. The New York Botanical Garden. A cold, rainy day did not prevent two members of the Rockland County Audubon Society who had never visited the Botanical Garden before and Mr. James Murphy, who had just returned from an extended trip in foreign countries, from attending this walk. Mr. Murphy gave generously of his vast knowledge of plant life, which was appreciated by the group. Attendance: 4. Leader, Jane Meyer.

May 11. Tock's Swamp, Kittatinny Mountain, N. J. Though the season should have been about right, we found no Rhodora in bloom. A few flowers of the bunchberry were seen. The ice storm of the past winter considerably hampered our walk on the Trail.

Songs of the northern water-thrush and the Canada and hooded warblers came from the swamp, while the Nashville warbler was singing on the ridge top. Attendance: 4. Leader, David Fables.

May 22–24. Sussex County, N. J., Nature Conference. Though conducted under somewhat adverse circumstances, those in attendance at High Point State Park apparently enjoyed the trips. With headquarters at the Lodge the group searched for birds on Saturday morning (despite a very high wind) in High Point Park and Strokes Forest. Botanizing followed, under the leadership of Louis Hand, at the "Pines" near Branchville and the Cedar Swamp at High Point. Pictures of New Jersey wildflowers were shown after dinner. On Sunday Woodruff's Gap and Lafayette were visited for birds, and the Springdale–Greendell region for plants. Among the flora observed were: showy orchis, small yellow lady's slipper, fairy wand and adder's tongue fern. Among the birds: Florida gallinule, alder flycatcher and barrel owl. The bird list was 102 species, though no special effort was made to obtain any sizable count. Attendance 26. Leaders, Louis Hand and David Fables.

May 31. Great Kills Marine Park, Staten Island, N. Y. The usual plants of the strand were observed but more attention was devoted to birds. The brackish pond revealed: black-crowned night heron, green heron, black duck, blue winged teal, long-billed marsh wren, and killdeer. Along the sandy beach were many least terns, common terns, horned larks, and piping plovers. Killdeer, black-bellied plover, semi-palmated plover, rudy turnstone, least sandpiper, semipalmated sandpiper, sanderling, knot, red-backed sandpiper were seen on the peat spits. The tidal marshes added spotted sandpiper to the list. Attendance: 11. Leader, Mathilde P. Weingartner.

June 6. The Serpentine Barrens, Chester County, Pa. This tour included the three most important serpentine areas in the Torrey Range: Cedar barrens, about six miles east of West Chester; Unionville barrens approximately eight miles southwest of West Chester; and Nottingham barrens some five miles southwest of Oxford near the Maryland border. Previous trips to the Unionville and Nottingham barrens have been on April 30, 1932, May 4, 1941, and May 1, 1949 but only the latter appears in Torreya (Bulletin vol. 76, p. 465, 1949). These trips were to see the spectacular display of *Phlox subulata* and the serpentine chickweed (*Cerastium arvense* var. *villosum*). The present trip was planned for later flowering rarities.

Cool weather just prior to the trip held fameflower (*Talinum teretifolium*) to the bud stage but in the sunny, exposed parts of the barrens the following plants were seen in flower: *Arenaria stricta, Senecio Amollii, Oenothera fruticosa, Cerastium arvense* var. *villosum* (a few late flowering plants), *Sisyrinchium mucronatum*, and *Panicum depauperatum*. On one of the slopes at the Nottingham barrens, among the fairly open *Pinus rigida-Quercus marilandica-Q. stellata* growth, a fine colony of the dioecious *Chamaelirium luteum* was in full anthesis and nearby *Thalictrum revolutum* and *Gillenia trifoliata* were also in full flower.

A stop enroute was made at the Brandywine Creek to see one of the many large colonies of *Cronium maculatum* (poison hemlock) white with flowers. A new station for the yellow oak (*Quercus Muehlenbergii*) was discovered at the Cedar barren. Attendance: 14. Leader, Hugh E. Stone. Reported by L. E. Hand.

June 7. Staten Island, N. Y. Two areas were visited. Due to recent heavy rains, lush vegetation was encountered, the grasses especially being in excellent condition for identification. In a field of approximately 1 acre, seventeen species of spring-flowering grasses were identified in addition to other species of flowering plants. Attendance: 8. Leader, Robert Meyer.

June 7. Inwood Park, New York City. No customers appeared. Leader, Jane Meyer.

Book Reviews

The Algae of Illinois. By L. H. Tiffany and M. E. Britton. 407 pages; 1186 figures (108 plates). University of Chicago Press. Chicago, Illinois. 1952. $10.00.

This book, as "Algae of the Western Great Lakes Area" by G. W. Prescott, helps to fill the need for manuals by which species of algae can be determined. The authors are to be congratulated for the broad scope of the book. It includes the desmids and the diatoms which were not considered in "Algae of the Western Great Lakes Area." It will undoubtedly be very useful in a much greater area than the state of Illinois.

Each taxonomic category, beginning with the major algae divisions, is discussed concisely. The book provides keys to the classes, genera and species. As one would expect, the section on the Oedogoniales is particularly well done. It is to be regretted that the authors were unable to make original drawings. This is particularly true in the diatoms where many of the figures are inaccurate. Ecological information as to the distribution of the species would have been valuable added information.

The glossary should prove a useful aid to the beginner.—RUTH PATRICK, The Academy of Natural Sciences of Philadelphia.

Soil Microbiology. By Selman A. Waksman. vii + 356 pages; 130 figures; 77 tables. John Wiley and Sons, Inc. New York, 1952.

The book under review presents an introduction to the inhabitants of the soil microcosm and their activities. From an intimate and comprehensive experience, the author gives a broad review of knowledge in the field of soil microbiology. A large amount of information has been condensed into the pages of the book leading to a rather complete inclusion of subject matter. There is, however, considerable variation in the detail devoted to individual topics. References, practically all to papers in the English language, are given at the end of each chapter and will aid readers in finding further information.

Major attention is given in the book to three topics; the soil population, organic matter transformations, and transformations of nitrogen and its compounds. Three chapters totalling 60 to 70 pages of text are devoted to each of these subjects. The soil population is treated first with respect to the nature of the population as a whole, factors affecting its qualitative and quantitative nature, and methods used in studying it. This is followed by a discussion of the occurrence of specific organisms dealing principally with physiological groups but also with taxonomic groups and in some cases with individual species significant in soil processes. The discussion of organic matter transformations is concerned with the chemical nature of the organic residues returned to the soil and the effect of this upon their decomposition, the significance of their nitrogen content, and the products formed. Special attention is given to the decomposition of cellulose and lignin. Soil humus is discussed from the standpoint of its nature, formation, decomposition, and importance in soil fertility. The discussion of nitrogen transformations deals with the decomposition of organic nitrogenous substances and the accompanying formation of ammonia, nitrification of the ammonium compounds, denitrification, and nitrate reduction. Non-symbiotic and symbiotic nitrogen fixation are considered in some detail in separate chapters.

Single chapters are devoted to discussions of the transformations of mineral substances by soil microorganisms; microorganisms and soil fertility; stable manures, composts, and green manures; higher plants and soil microorganisms; associative and antagonistic effects of soil microorganisms; pathogenic microorganisms in the soil and their control; history of soil microbiology; and recent developments in soil microbiology.

The numerous figures and tables are a valuable feature of the book. Of the figures, slightly over one-half are photographic reproductions, a high proportion of these picturing microorganisms important in soil processes. These will give the student an excellent picture of the morphological or cultural appearance of many of the microorganisms discussed. The graphical figures and tables present a wealth of original data drawn from many sources which will, no doubt, be frequently referred to by both students and instructors. A number of the figures should be improved by use of more informative legends, these being particularly needed since few of the figures are discussed in the text. An occasional erroneous reference to tables or figures is found in the textual matter. Thus Figures 65–67 and Tables 42 and 43 do not give information on the particular points for which they are cited. Such discrepancies will prove puzzling to students. Occasionally,

there is found an unfortunate wording in the text. As an example, the last sentence on page 124, if interpreted literally, would indicate that humus can not be distinguished from the materials from which it is formed.

An especially attractive feature of this book is the series of 17 portraits of scientists who have had an important part in the development of soil microbiology or closely related sciences. The portraits begin with Lawes and Gilbert of the Rothamsted Experimental Station and extend to a number of workers still living. One feels that the series is incomplete through omission of a portrait of the author himself.—H. W. REUSZER, Purdue University.

New Zealand Pollen Studies, The Monocotyledons, a Comparative Account. Lucy M. Cranwell. 91 pages, illustrated. Harvard University Press 1953. Paper $3.50, Cloth $5.00.

This publication is issued as Bulletin No. 3 of the Auckland Institute and Museum. It is illustrated by 66 figures and 8 collotype plates of pollen grains, one map and a front piece.

This work is a continuation of that entered upon by the author in 1935 in association with Professor E. J. Lennart von Post. It is a description and systematic review of New Zealand pollen types as a preliminary to palaeoecological and palaeoclimatological researches. With the idea of aiding in the identification of pollen grains recovered from ancient deposits the author furnishes descriptions of the pollen grains (many of them illustrated) of 11 orders, 18 families, many genera and species of plants presently growing in New Zealand.

A key is furnished to this array of pollen forms. It is entirely artificial, based mostly on superficial characters rather than those that are of fundamental importance. The key's four primary divisions are 'dyads,' 'tetrads,' 'reduced tetrads,' and 'monads,' according to whether the grains are borne in twos, fours or singly, or whether the pollen mothercell is transformed directly into a single grain by the suppression of three daughter nuclei, "typical of Cyperaceae but not always recognizable as such." The first three primary divisions lead to Orchidaceae, Liliaceae, Juncaceae, Gramineae and Cyperaceae in part, leaving all the rest in the fourth division 'monads.' Moreover these five families reappear in the 'monads.'

There is also a table of Salient pollen characters of New Zealand Monocotyledons, including also the Coniferales and "lower native spermatophyte taxa with comparable microspores." Taxa (Taxon sing.) is defined as taxonomic groups of varied ranks.

For the New Zealand flora generally, the author states, wind pollination is very common, about 29 per cent as compared with 21 and 23 per cent for the German and Swedish floras. Among the Monocotyledons about 74 per cent of the genera are wind pollinated. The families of greatest ecological importance, especially those of open formations such as bog, swamp and grassland are anemophilous. This, of course, is a strong argument in favor of a more extended use of pollen analysis in palaeoecological and palaeoclimatological studies.

For each of the orders the author discusses the various pollen forms found in the group and their relation to the classification of the group components and the position of the order in the general classification. Sometimes, as in the Potamogetonales, a key as furnished which is valuable in pointing up the distribution of the various forms within the order.

The author states that, strong ties between New Zealand and Australian orchids, in particular, suggest that pollen or seeds might come to New Zealand with the prevailing winds that sometimes coat New Zealand glaciers with red Australian dust.

This little book will certainly be valuable to anyone interested in New Zealand pollen. Outside of this its many and varied contacts and side lights can be stimulating and thought provoking even to those who have no particular interest in the New Zealand flora nor its pollen.—ROGER P. WODEHOUSE, Lederle Laboratories Division, American Cyanamid Co., Pearl River, N. Y.

The Fungi, a Description of their Morphological Features and Evolutionary Development. By Ernst Albert Gaumann and Frederick Lyle Wynd. 420 pages; 440 figs. Hafner Publishing Co., New York and London. 1952. $10.00.

The original text was in German (page 4 but not cited in bibliography) and the junior author assumes responsibility for its translation and arrangement as an American text. The bacteria and slime molds are excluded to leave the true fungi—the Eumycophyta of recent textbooks of general botany such as that of Fuller & Tippo and, more recently, Northen. The irrefragable Archimycetes are recognized as a class derived from the flagellates. They are considered to be a terminal group and the Phycomycetes are also derived from the flagellates through th Chytridials, except that the Oomycetes are assumed to come from the Syphonales. In the developmental diagram (page 10) the Zygomycetes lead to the Ascomycetes. "The ascus . . . evolved from the germinating sporangium of the Zygomycetes . . ." (p. 255). It is not so easy to pinpoint the transition from Ascomyetes to Basidiomycetes and this is not attempted. The major evolutionary hurdle appears to be acceptance of the basidium as an ascus producing spores exogenously (p. 256). The binucleate mycelium of the Basidiomycetes can be disposed of as ascogenous hyphae which have become nutritionally independent. The mechanism of asexual reproduction, except for uredospores, and the continued suppression of sexuality are further similarities between these two groups. Rusts and smuts are placed highest in the evolutionary diagram, perhaps because of the probasidium, although the Uredinales at least are recognized as a very ancient group of plants. An interesting point is made that, at least in some species of smuts, karyogamy and meiosis come about in the probasidium. "The basidium, in this stage of retrogression, has sunk to the level of an asexual fruiting organ, the very level from which its ancestor, the ascus, began its upward evolution."

The Basidiomycetes are divided into Holobasidiomycetes (formerly Autobasidiomycetes) and Phragmobasidiomycetes (formerly Protobasidiomycetes). Although the latter, consisting of jelly-fungi, smuts, and rusts, "probably have evolved from the" former, such a relationship is not particularly implied in the developmental diagram. It is more certainly implied by their later treatment in the text arrangement. The term Hemibasidiomycetes does not appear, nor does the Order Daerymycetales. Another missing term is Deuteromycetes, and the fungi imperfecti (decapitalized) receive scarcely more than a page—this as an appendix. There is no mention of lichens.

An outstanding feature of this book is the diagrammatic representation of development with the fungi. The text treatment is also developmental and the selected species carry this along very well, though subject to some disagreement among the specialists. On the other hand the book can hardly expect wide adoption as a textbook due to the omissions cited above. The illustrations arouse mixed feelings. There are scarcely more than a half dozen originals and these are only diagrammatic representations of structure (figs. 195, 279, 297, etc.). A few photographs appearing for the first time in this book are credited "original photograph by Photographic Institute E. T. H." (figs. 218, 224 etc.). This leaves a huge number of borrowed figures. These, dating from Tulasne, 1851 (fig. 352), may be of interest to the historically inclined as illustrations of the work of early mycologists. Some can hardly be justified on other grounds though many are satisfactory representations of structure—there are few real drawings. Readers may feel that the authors have not been out among the fungi nor displayed personal enthusiasm for the subject as a presently developing field of knowledge.

Pertinent references at end of chapters are more easily located and perhaps more likely to be consulted than when assembled in a general bibliography. This book, in fact, has no chapters. Each of the four Classes starts a page, but with no formality. Keys take one to the orders and thence to the families where several genera will usually be discussed, though the book is obviously not intended as a manual for identification. No attempt was made to find errors but the reader will find the Zygomycetes treated on page 73 rather than on page 23 as indicated in the key (p. 30). The typography and

press work are excellent and pleasing.—JOHN A. SMALL, New Jersey College for Women, Rutgers, The State University of New Jersey.

NOTES

The Nature Conservancy has called itself to our attention by a frontal approach to President Simpson. The release states: "We believe your organization may be an important influence in the movement to preserve America's heritage of nature." Are we or should we be such an influence? A Local Flora Committee is provided for in our Constitution but it has not been manned in the appointments of recent presidents. We have no Conservation Committee.

"We also want to invite your group to become a member of the Conservancy. Minimum dues are low ($2) so that any group [or individual] can join." Our Council has ventured $2 and will assess the impact of this alliance upon nature.

The Club "is entitled to take out group subscriptions to Nature Conservation News at the rate of 50¢ each (minimum of 4)." The subscriptions, addresses, are assembled and forwarded with a single check. Since the Conservancy operates on the calendar year it seems too late to attempt this for 1953. Do you believe we should do so in 1954? The writer believes it more desirable for individuals to become members directly in their own right. Their names will then be sent to their state representative and they can be active in the local group. The $2 or any larger amount should be sent to The Nature Conservancy, 1840 Mintwood Place, N. W., Washington 9, D. C. But you might urge your local garden club, nature club, or scout troop to join. J.A.S.

The Eighth International Congress of Botany will be held in Paris from Friday the 2nd to Wednesday the 14th of July, 1954. Lodgings will be provided at rates ranging from steerage to first class. Pre- and post-congress excursions will extend the dates from June 15 to well into August and geographically from the Alps to Tropical Africa. The Congress will include plenary sessions, sessions on various subjects, symposia, and some backstage meetings. We have no information about delegates at this time. The probable amount of the subscription is now placed at $15. Reservations and further information may be had from the Secretariat General du 8e Congres International de Botanique, 292 Rue Saint-Martin, Paris (3e), France. J.A.S.

Island Beach, N. J., an off-shore bar some ten miles long in Ocean County, was acquired by the State on July 1 for use as part of the State Park system. The area has been in the long range park plans of the State for nearly forty years. For over twenty-five years it has been held by the Estate of Henry Phipps and operated as the Barnegat Bay and Beach Company. The Estate held the land for investment purposes and they were offered large sums for certain portions of the area. They were also conscious of the uniqueness of the area and deserve a good deal of credit for resisting piece meal disposition until this time when the State was able to acquire the whole parcel. Credit in large measure should also be recorded for the work of the late Francis P. Freeman, long time resident manager, and Mrs. Freeman who kept the heirs conscious of the esthetic and natural history value of the property as a whole. More recently Captain Joseph Tilton has discharged this responsibility with remarkable care.

Present plans contemplate a recreation area about midway down the bar when funds become available. It is expected that the upper third will remain a general nature sanctuary since here one finds the most remarkable plants, a large assortment of birds and other animals. The lower third will also be a sanctuary since here are the heron rookery, nests of ospreys, and the nesting area of terns and other birds that prefer the bare sand. The sanctuary areas will be open to interested groups and individuals when it is possible to provide adequate guide service for the purpose. Fine examples of heather balds, dunes, cedar (juniper) forest, and thickets can be seen from the roadway by those passing through. It must be remembered that there are no sanitary or parking facilities now so be patient and encourage the provision of funds for such purposes. Mr. F. I. Dewald, Department of Conservation and Economic Development, State House Annex, Trenton 7, will handle special requests. Please do not go down and give the poor gateman a rough time.—J. A. S.

BULLETIN OF THE TORREY BOTANICAL CLUB

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COMPILED BY

LAZELLA SCHWARTEN

WITH THE COLLABORATION OF THE EDITORS OF THE TAXONOMIC INDEX

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